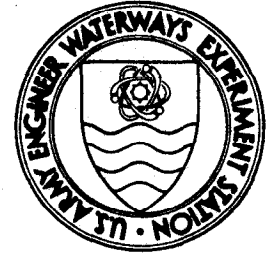


DREDGED MATERIAL RESEARCH PROGRAM



CONTRACT REPORT D-75-1

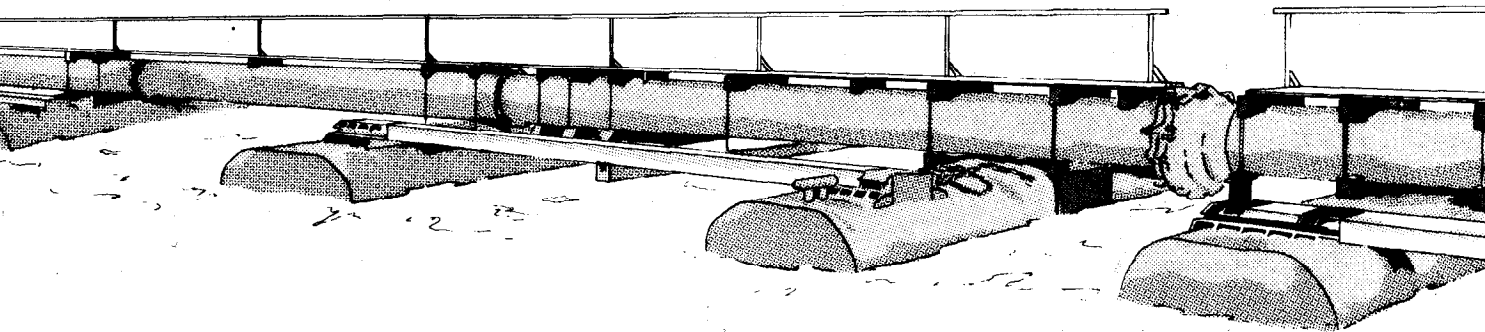
A FEASIBILITY STUDY OF LAWN SOD PRODUCTION AND/OR RELATED ACTIVITIES ON DREDGED MATERIAL DISPOSAL SITES

by

Arthur D. Little, Inc.
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January 1975
Final Report

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Prepared for Environmental Effects Laboratory
U. S. Army Engineer Waterways Experiment Station
P. O. Box 631, Vicksburg, Miss. 39180

Under Contract No. DACW39-74-3-0101

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IN REPLY REFER TO: WESYV

31 January 1975

SUBJECT: Transmittal of Contract Report D-75-1

TO: All Report Recipients

1. The contract report transmitted herewith represents the results of the first research effort completed as part of Task 4D (Products Research) of the Corps of Engineers' Dredged Material Research Program (DMRP). Task 4D is included as part of the Productive Uses Research Project of the DMRP, which, among other considerations, includes developing concepts for productively using disposal areas or dredged material removed from these areas.
2. There has been a dramatic increase in the last several years in the amount of land disposal of dredged material, necessitated largely as a result of the need for confining dredged material classified as polluted. Land is continuing to become more and more scarce for disposal activities, and the problem becomes more acute with the need for selecting each new disposal area. Attention therefore can be profitably and justifiably directed towards concepts which can increase the life of disposal areas, thereby reducing the need for additional facilities.
3. DMRP work units are in progress under other tasks aimed at developing improved disposal facility operation and management procedures as well as techniques for the reclamation of potentially valuable materials, both of which could increase area life expectancy as well as enhance their aesthetic and environmental characteristics. However, the total picture would be incomplete without considering concepts for developing marketable products from the dredged material itself or from the disposal areas. To this end, the investigation reported herein was accomplished under contract with Arthur D. Little, Inc. The report presents concepts for the use of disposal areas as production sites for various horticultural species. Since the market for these products is presently supply constrained, horticultural production appears to be an attractive alternative in a number of areas.

WESYV

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4. The study concludes that commercial production of horticultural crops is feasible on disposal areas that have been filled and deactivated. Production on active sites is infeasible because of the numerous inefficiencies and production losses that would occur with disposal operations. Economic incentives for producers were identified as high gross income per acre for most crops, strong growth of the market, and consistent pressure for expansion of production facilities.

5. In keeping with the philosophy of the DMRP, no attempt has been made to specify precisely where or under what conditions this productive use alternative would be feasible or desirable. Rather, relevant factors pertaining both to the industry and disposal sites and operations have been evaluated with emphasis placed on identifying limiting conditions and constraints. This information is presented in the form of a decision matrix that can be used by the Corps District Engineer, the product sponsor, or other party in determining the feasibility of this concept for a particular project or location with which he is concerned and for which he has or could develop detailed information.

6. An additional intent of this study and this report is to promote more widespread interest in and concern over the subsequent use of disposal sites for productive purposes. To this end, it is expected that the basic conceptual design and methodology employed in this study may be of greater long-term significance to persons concerned with land-use planning and management rather than with the specific products of commodities with which this study was involved.



G. H. HILT

Colonel, Corps of Engineers
Director

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20. ABSTRACT (Continue on reverse side if necessary and identify by block number) The study was designed to evaluate the technical and economic feasibility of the use of dredged material disposal sites for the commercial production of lawn sod or for other horticultural activities. Included in the investigation was the identification of various practices--marketing, production, organization, and cultural--that would influence the long-term development of such activities on disposal sites. Major classes of nonfood horticultural products analyzed to determine whether they could be grown commercially on disposal (Continued)		

20. ABSTRACT (Continued).

sites included lawn sod, nursery products, foliage plants, vegetable and flower seeds and bulbs, and Christmas trees. Technical feasibility of commercial production was tested through a concurrent evaluation of disposal site characteristics and appraisal of critical production and cultural practices for the horticultural crops. Economic feasibility was assessed by two criteria: *Is the market structure conducive to use of disposal sites? What is the economic advantage or disadvantage of production on disposal sites (based on production cost differentials discovered in the technical analysis)?* Several disposal site characteristics were identified as most likely to militate against horticultural production. These include weeds, salinity, contaminants, and inundation. Other deterrents might be poor accessibility, size and location not amenable to production needs, and disruption of production by disposal operations in the case of an active site. Study of economic constraints showed that horticultural crops, except Christmas trees, require heavy capital investment in site preparation and continuous production activities. These crops also must have long-term, stable production environments. The economic incentives were identified as high gross income per acre (except for Christmas trees), strong growth of the market, and consistent pressure for expansion of production facilities. Locational advantages are often an important decision factor for horticultural producers. The following major conclusions resulted from the study: (1) Commercial production of horticultural crops is not recommended for active dredged material disposal sites. Such production is not an annual occurrence, but is a continuous process involving complex interactions of land and producer. Disruption of this process would cause numerous inefficiencies and production losses. (2) Commercial production of lawn sod, nursery products, foliage plants, and Christmas trees is feasible on mature sites, subject to certain constraints. (Criteria for production of horticultural crops on dredged material disposal sites are given in the report). (3) The establishment of commercial horticultural production on suitable mature disposal sites should be relatively simple to accomplish given the information exchange system present within the industry and the interest in these sites by industry representatives.

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COMMERCIAL PRODUCTS.

FOREWORD

This report presents the results of an investigation of one aspect of multiple use of dredged material disposal sites. This investigation, "A Feasibility Study of Lawn Sod Production and/or Related Activities on Dredged Material Disposal Sites," was conducted under Contract No. DACW-39-74-3-0101 between the U. S. Army Engineer Waterways Experiment Station (WES), and Arthur D. Little, Inc., Cambridge, Mass. The research was sponsored by the Office, Chief of Engineers (DAEN-CWO-M) under the Civil Works Research Program (Dredged Material Research Program).

Information presented herein includes: A description of the horticultural industry; the characteristics of dredged material disposal areas as related to potential horticultural production; the economic and technical constraints facing this production activity; and recommendations regarding the potential establishment of horticultural enterprises on dredged material disposal sites.

This study was conducted by personnel of Arthur D. Little, Inc., authored under the supervision of Fred W. Besley and Donald M. Senechal. Major participants included William C. Hale and DeWayne E. Whitehead.

The contract was monitored for the Waterways Experiment Station, Office of Dredged Material Research,* by CPT Robert M. Meccia under direct supervision of Dr. Roger Saucier and general supervision of Dr. John Harrison, Chief, Environmental Effects Laboratory, WES. The Director of WES during the period of this contract was COL G. H. Hilt, CE. Technical Director was Mr. F. R. Brown.

* The Office of Dredged Material Research became part of the Environmental Effects Laboratory in July 1974.

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EXECUTIVE SUMMARY

A. PURPOSE AND SCOPE

The objective of this study was to determine the technical and economic feasibility of commercial production of lawn sod or related live horticultural crops on active or mature (i.e., inactive with drying substantially completed) dredged material disposal sites. The study itself was, in turn, a means by which the Waterways Experiment Station of the Corps of Engineers could fulfill its larger objective of providing information to decision makers within Corps Districts concerning environmentally beneficial alternative uses of dredged material disposal sites.

Because of the large number of disposal sites and the variations in the structure of the sites, this study was conducted with the mission of providing a set of general guidelines for successful commercial horticultural production on disposal sites. Furthermore, because of the intended long-term use of this document in multiple-use planning, effort was made to identify various marketing, production, organization, and cultural practices that will influence the long-term development of such horticultural activity.

B. APPROACH

The broad scope of the research dictated that major classes of non-food horticultural products be analyzed to determine whether they could be grown commercially on disposal sites. The classes of live horticultural products studied were:

1. Lawn sod
2. Nursery products
 - a. Woody ornamentals
 - b. Flowering plants and other nonwoody ornamentals
3. Foliage plants
4. Vegetable and flower seeds and bulbs
5. Christmas trees

Technical feasibility of commercial production was tested through a concurrent evaluation of disposal site characteristics and appraisal of critical production and cultural practices for the horticultural crops. Economic feasibility was assessed utilizing two sets of criteria:

1. Is the market structure conducive to use of disposal sites?
 - Is it an expanding market?
 - What impetus is there to relocate production facilities?
 - What location advantages are potentially available through use of disposal sites?
2. What is the economic advantage or disadvantage of production on disposal sites, based on production cost differentials discovered in the technical analysis?

C. FINDINGS

1. Disposal site characteristics most likely to militate against horticultural production are:

- a. Disruption of production by usage of active sites
 - b. Weeds
 - c. Salinity
 - d. Toxic and other detrimental contaminants
 - e. Poor accessibility
 - f. Size and location not conforming to production needs
 - g. Inundation
2. Horticultural crops, with the exception of Christmas trees, require heavy capital investment in site preparation and continuous production activities.
 3. Horticultural crops require long-term, stable production environments.
 4. Horticultural crops, with the exception of Christmas trees, return a very high gross income per acre in comparison with other agricultural crops.
 5. The horticultural live product market has shown, in general, strong growth and has actually been constrained by supply.
 6. There is strong pressure for expansion of production facilities and consolidation of production units within the horticultural live product industry.
 7. Locational advantages often are an important decision factor for horticultural producers.

D. RECOMMENDATIONS

1. Commercial production of horticultural crops is not recommended for active dredged material disposal sites. The combined effects of heavy capital investment in fixed production facilities, the generally lengthy cycle of production, and the risk associated with high-value crops negates the possibility of successful commercial production in all but the most unusual circumstances. Agricultural production, be it horticultural crops, grain, or forage, is not an annual occurrence, but rather a continuous process involving complex interactions of land and farmer. Disruption of this process would cause numerous inefficiencies and production losses.
2. Commercial production of lawn sod, nursery products, foliage plants, and Christmas trees is feasible on mature disposal sites, subject to certain constraints. Production of seeds and bulbs is not likely to be of interest to seed producers because of the need for land of proven production potential for these extremely high-value crops. Table 1 summarizes the criteria for production of horticultural products on dredged material disposal sites.
3. The establishment of commercial horticultural production on suitable mature dredged material disposal sites should be relatively simple to accomplish given the information exchange system present within the industry and the interest in these sites by industry representatives.

Table 1

Criteria for Production of Horticultural Products on Disposal Sites

Site Characteristics	Crop			
	Lawn Sod	Nursery Products Woody	Flowering	Foliage Plants Christmas Trees
Mature disposal site	✓	✓	✓	✓
Long-term lease or purchase available	✓	✓	✓	✓
Minimum size: 5 to 20 acres	✓	✓	✓	✓
30 acres	✓*			
100 acres	✓			
Primary soil type: Sand	✓	✓**	✓**	✓
Organic silt	✓	✓	✓	
Irrigation water available	✓	✓	✓	✓
Labor force available	✓	✓	✓	✓
Maximum distance from major marketing area: 75 miles	✓	✓	✓	
400 miles	✓	✓	✓	✓
Substantial vegetative growth now on site	✓	✓	✓	✓
No salinity problem	✓	✓	✓	✓
Drying of site completed	✓	✓	✓	✓
Access roads capable of carrying heavy truck traffic†	✓	✓	✓	✓
Maximum land value per acre: \$ 150	✓	✓	✓	✓
\$1200††				
Land value less than typical industrial park site		✓	✓	✓
Southern coastal location		✓	✓	✓
No excessive smog		✓	✓	✓
Site secure from erosion	✓	✓	✓	✓
Site near existing horticultural industry	✓	✓	✓	✓
Ability to establish marketing channels	✓	✓	✓	✓
Marketing area experiencing growth	✓	✓	✓	✓

✓ Necessary criterion for specific crop

* Relatively small acreage may be useful for those producers wishing to participate on a part-time or expansion basis.

** Greenhouse or container growing removes soil constraint.

† In certain cases barge movement may be an alternative transportation mode.

†† Subject to regional variation.

CHAPTER I: INTRODUCTION

A. BACKGROUND

The Waterways Experiment Station of the Corps of Engineers, as a part of its program to study the environmental effects of dredged material disposal, is concerned with the development of programs for multiple use of dredged material disposal areas. Multiple use of a diked disposal area entails the use of the confined land area for disposal of dredged material and also for other uses beneficial to the general public. Beneficial uses might include production of artificial marshland, improvement of wildlife habitat, production of agricultural crops, or development of recreation areas. These uses would make the disposal area more acceptable to the community and integrate it into the community's needs.

Under the auspices of this multiple-use development program, the Dredged Material Research Program, and through the direction of its staff, this study was undertaken to determine the feasibility of commercial production of lawn sod or related horticultural crops on active or mature dredged material disposal sites. The purpose of this study is to provide decision makers within the Corps Districts and local governmental units with the information necessary to enable consideration of horticultural crop production as an alternative use of dredged material disposal areas.

Lawn sod and related horticultural products are logical candidates for this multiple-use program. Production of these crops is aesthetically pleasing, common throughout the nation, and generally commercially attractive. The total value of horticultural sales in 1974 is estimated to exceed \$1 billion. In recent years an annual growth rate of 8 to 10 percent has been observed industry-wide.

Because of the large number of crops studied, the large number of disposal sites considered, and the variability of site conditions, this investigation was not intended as a feasibility study specific to a single site or group of sites. Rather, the intent was to describe the horticultural industry including production and marketing practices, long-term trends in these characteristics, and the characteristics of disposal sites most likely to impact on horticultural production. This information was then correlated to form a set of general guidelines for those entities wishing to consider use of dredged material disposal sites as locations for commercial horticultural production.

B. APPROACH

The broad mission of this study dictated that major classes of nonfood horticultural products be analyzed to determine whether they could be grown commercially on dredged material disposal sites. The classes of horticultural products studied were:

1. Lawn sod
2. Nursery products
 - a. Woody ornamentals
 - b. Flowering plants and other nonwoody ornamentals
3. Foliage plants
4. Vegetable and flower seeds and bulbs
5. Christmas trees

In order to determine the feasibility of commercial production of these crops, both the technical and economic feasibility of production of these crops were studied through two concurrent tasks.

1. A study of active and mature disposal sites was undertaken.

The site characteristics most likely to impede or enhance horticultural production were defined. The incidence and severity of these characteristics were also delineated.

2. A study of the production environment was made. This task analyzed current horticultural systems and identified critical practices and environmental conditions. In addition, long-run trends and industry organization were analyzed.

These tasks were accomplished through extensive literature search and discussions with government personnel and industry representatives.

Following completion of these tasks, the information obtained was correlated to determine which horticultural crops would be technically feasible for commercial production on disposal areas. In addition, criteria or essential characteristics of a site for production were defined.

Economic feasibility was assessed utilizing two analyses.

1. Marketing - Industry market structure was analyzed to determine whether future market trends indicated an atmosphere conducive to expansion of production onto disposal sites. Market information was gathered, including:
 - a. Size of market and potential for expansion
 - b. Impetus for relocation of production facilities
 - c. Locational and transportation structure
2. Comparative Advantage Analysis - The results of the technical feasibility analysis and the marketing study were evaluated to determine the comparative advantage or disadvantage which various horticultural products on disposal sites would incur.

Following completion of this analysis, recommendations concerning feasibility of production by major product class, essential site characteristics, potential site customers, and methods of initiating horticultural production were made.

CHAPTER II: CONFINED DISPOSAL AREAS

A. GENERAL DESCRIPTIONS

Basically disposal sites are areas of land which are surrounded by dikes used to confine dredged material. They vary from 5 to 2500 acres, depending on the size and number of dredging operations to be accommodated, and generally fall into two categories:

1. Those that are used for one or two dredging locations over a limited number of years; generally these occupy between 20 and 200 acres.
2. Those that are used as a central disposal area and which will accommodate long-term dredging operations; generally these occupy between 500 and 2000 acres.

The small localized confined areas outnumber the large areas by about 10 to 1. No studies have been done on relative capacity, but the small disposal areas probably outweigh the large ones in cubic yards of dredged material accommodated (although not by so large a margin).

Dredging in fresh water is found throughout the country in (1) the Great Lakes area, (2) channels of major rivers, and (3) along the coast where port activities extend upriver into freshwater areas.

In the Great Lakes, about 11 million cu yd of material is dredged annually with most of it deposited in confined disposal areas. Because of the difficulty in locating disposal areas, some of this material is being deposited in approved open-water areas in the lakes. Confined disposal areas, however, are numerous in the Detroit and

Buffalo Districts. The Chicago District, with less than 1/4 of the dredging requirements of the Great Lakes area, has a limited number of disposal areas.

Dredging of channels in major rivers in the interior of the United States occurs in the following Districts.

<u>Corps District</u>	<u>Estimated Annual Dredging 10⁶ cu yd</u>
Memphis	25.6
Vicksburg, Mississippi	15.6
St. Louis	8.3
Kansas City	4.5
St. Paul	2.5
Louisville	2.5
Rock Island, Illinois	1.0
Huntington, W. Virginia	0.4

The total annual volume of dredging for these Districts is about 60.4 million cubic yards. However, for all of these Districts, less than 5 percent of the disposal is confined (less than 3 million cu yd). Since disposal areas are highly dispersed among these Districts, only large, long-term disposal areas (if they exist) would be of interest in terms of this study.

Coastal dredging is comprised of material from freshwater, brackish, and saltwater areas. If materials from river channels and intercoastal waterways can be considered as coming from fresh water, the following Districts and volumes are involved.

<u>Corps District</u>	Estimated Annual Dredging 10^6 cu yd
New Orleans	30.2
Galveston	15.5
Mobile	8.4
Portland	7.1
Sacramento	1.4
Charleston	1.1
Philadelphia	1.0
Savannah	0.9
Wilmington	0.8
Seattle	0.8
Norfolk	0.4
Jacksonville	0.3

The total annual volume for these Districts is 67.9 million cubic yards with New Orleans, Galveston, Mobile, and Portland accounting for almost 90 percent of the total. For these four Districts, the amount of dredged material placed in confined disposal areas is uncertain. As an indication, however, confined disposal accounts for 20 to 30 percent of all dredged material disposal in these Districts (fresh, brackish, and saltwater materials).

These data indicate that freshwater confined disposal is found in high concentrations in the Great Lakes area. Coastal areas such as those discussed above may constitute the greatest number of freshwater confined areas, although further study is needed for these areas. Interior Districts, such as those along the Mississippi, may not be of importance to this study because of their use of unconfined disposal areas.

The dikes that confine the disposal areas can be anywhere from 5 to 40 ft high, depending again on the amount of dredged material to be accommodated. At short-term disposal sites, especially in the

southern states, the dikes usually are constructed of available nearby material. This can be material either from inside the confined area or from the perimeter. The larger long-term areas generally use material chosen on the basis of its stability characteristics rather than its immediate availability. Often various combinations of stone, clay, and sand are used to meet the particular structural demands of the surrounding environment. (For example, coarse large stone, called riprap, is used when wave action might erode the dike.) Dikes higher than 5 to 10 ft usually are constructed in tiers, with secondary dikes built on the settled dredged material within the inside of the original dike.

The visual appearance of disposal areas is determined by the appearance of the dike since most disposal areas are viewed from surrounding low flat areas. The material within the disposal area is usually not visible.

Within the disposal area, the state of the dredged material is dependent on the stage of settling. When the material is first pumped into the disposal area as a slurry, it has a solids content of about 7 to 25 percent. In most disposal areas this material is allowed to remain undisturbed for a few hours to a few weeks to allow the dredged material to settle out. The water, with remaining smaller particles, is then decanted through a sluice or weir--usually a wooden gate of variable height which allows control of the amount of water being decanted. After a few weeks, the material remaining in the diked area is about the consistency of toothpaste; that is, soil particles are

saturated with interstitial water. Water continues to drain from the disposal area during this period. The first part of the disposal area to dry will be the surface (by evaporation of the surface interstitial water after decanting of the free water).

The surface layers will be composed of the finer particles; i.e., the last ones to settle out. If an appreciable amount of fine silt or clay-size particles are present, desiccation cracks will form during the drying process. These cracks in turn fill with water and, since the surface is usually uneven, water also may be trapped in small pools at this stage.

The material dries from the perimeter of the disposal area inward towards the center. Unaided, the material may take over 10 years to dry completely. (A disposal area on the Detroit River was inspected that had a marshy area in the center which was about 10 ft in diameter. The disposal area had not been used for 12 years.) The drying time depends on the nature of the material (the larger the particle size, the faster the water will drain), meteorological conditions (rain, humidity, etc.), proximity to water table, and other factors.

In most active sites, however, the material does not dry completely before the disposal site is used again. An active site may be used anywhere from once a month to once every five years. Its use depends on its size, the number of dredging projects to be accommodated, and the frequency of dredging to be done in those projects. The new material compresses the existing material to some degree, reducing its volume.

Inactive sites are generally used, after drying, for light industry, parking areas, or recreational purposes. If the disposal sites

are allowed to vegetate naturally, they follow the natural vegetative succession pattern for that area. For instance, in the 12-year old site mentioned earlier (on the Detroit River), the following hydrarch (wet to dry) succession was apparent. In the very center, where the material was still damp and spongy, dead water parsnips were giving way to a ring of sedge. This sedge formed a transition to drier ground where a multitude of early stages of open-field plants formed a dense, varied cover. These open-field plants included thistle, golden rod, oleanthus, daisy fleabane, and deadly nightshade. Possibly because of a high nutrient content in the dredged material, some of the plants appeared to be oversize, with thick patches of golden rod over six feet tall. (These may have been regional variations, however.) Smartweed formed a ring around these plants and separated them from the young trees. The ring of trees included dogwood and willow toward the inside with a ring of poplar around the edge.

B. POSSIBLE PROBLEMS WITH INACTIVE DISPOSAL AREAS RELATING TO USE FOR GROWING MARKETABLE PLANTS

1. Weeds

The above description of natural plant succession indicates that "undesirable vegetation" can obtain a stronghold on an active disposal area. In areas where vegetation was planted by the Corps, e.g., honeysuckle in Detroit and millet in Mobile, the planted material was crowded out by natural successional plants. In one disposal area in Toledo, the tomato seeds from a food-processing factory upstream sprouted profusely in the dredged material. This is not a usual occurrence, but it is another method of introducing competitive vegetation that should be considered.

Weed competition is most serious in disposal areas which involve freshwater-drained agricultural areas. These areas include much of the Great Lakes area, the Mississippi River, and southern harbor cities, such as Mobile. In these areas, nutrient-rich silt comprises much of the dredged material.

2. Saltwater Areas

Vegetation is difficult to establish in areas of high salinity. At some of the sites visited in the Norfolk area, a predominantly saltwater area, three years were said to have passed before the first vegetation became established (compared to a few weeks or months needed in freshwater areas on some sites outside of Norfolk). The species which became established were salt tolerant. This may indicate that a significant amount of salt had not leached from the area during those three years.

Occasionally salt water can become mixed with dredged material from freshwater areas if the material is transported by a hopper dredge or barge to a disposal site in a saltwater area. In order to pump the water into the disposal area, it must be mixed with surrounding salt water during pumping operations. The end result for the disposal areas is repeated applications of salt regardless of the source of the dredged material.

The amount of salt which is leached from dredged material by rainfall is open to question. It seems likely that some salt is leached out but that the process is very slow. Earlier it was explained that the finer materials settle last, forming a clay-like layer on top of the

disposal area. This layer dries first and forms a crust which can become relatively impermeable to rainfall, as indicated by the numerous pools of water that form in low areas after rain.

3. Toxic and Other Detrimental Contaminants

Chemical contaminants may also limit the potential for vegetating disposal areas. Since much of the dredging in the United States is conducted in industrial areas, the dredged material contains a variety of chemical contaminants from industrial effluents. Dredging also takes place in harbors containing alluvial soil from agricultural areas. This material often contains heavy metals, pesticides, and high nutrient concentrations from fertilizer runoff.

All of these contaminants may be concentrated in the disposal area in one way or another. An important consideration is the solubility of the contaminants within the disposal area since soluble forms are more readily available to the biological food chain. Vegetation in and around the disposal site may be a route for incorporation of pollutants into this food chain. Other studies have shown that mercury, in its methylated form, can become concentrated in the tissues of Spartina alterniflora far in excess of levels in the surrounding environment (although this same species can regulate its uptake of most other heavy metals). The chemical composition of the substrate has also been found to limit species diversity.

4. Size and Location

The variability of size among disposal areas has been discussed previously. The short-term sites are generally between 20 and

250 acres. The long-term sites are generally between 500 and 2,000 acres but can be as large as 2,500 acres. The smaller disposal areas are usually located farther away from metropolitan areas since they often accommodate isolated dredging operations. These isolated sites are usually located in riparian areas adjacent to land with little or no land access. The larger disposal areas are usually located closer to metropolitan areas since they need to be centrally located. Some large disposal areas are on islands but most are riparian and adjacent to land (usually industrial land) with access built into the design for maintenance purposes.

Table 2 indicates some of the general characteristics of confined disposal areas within a number of CE Districts.

To lower the cost of transporting the dredged material, the disposal areas are located as close to the dredging operations as possible. This means that disposal areas are usually located:

- . On existing islands.
- . In low shallow areas surrounded by water.
- . In shallow areas adjacent to land surrounded on three sides by water.
- . Completely on land (upland).

Riparian disposal, which usually refers to the third type but which occasionally may also refer to the second, accounts for over half of all confined disposal, while upland and island disposal accounts for the rest.

Table 2
Regional Characteristics of District Disposal Areas

CE District	Quantity of Con- fined Dredged Material 10 ⁶ cu yd/yr	Nature of Dredged Material	Disposal Area Location	Approximate Disposal Area Size (Acres)	Proximity to Populated Areas
Philadelphia	8	Sand, silt, clay, gravel	Riparian Upland	20-1200	Sites both remote and near residential areas
Norfolk	3.5	Mud, some sand	Riparian	2,500	Near residential development
Charleston	5.8	Sand, silt, clay (organic sludge in Georgetown & Charleston Harbor)	Riparian	600-800 2-150	Remote
Savannah	6.5	Sand, silt, clay	Riparian	700-2000	Remote
Jacksonville	0.2	Maintenance: Sand, silt, mud New Work: Sand, silt, mud, shell, rock, clay	Upland	2-100	Near residential areas
Buffalo	0.2 0.6	Maintenance: Sand, silt New Work: Clay, silt, sand, gravel	Riparian	50-75	Site both remote and near residential areas, airport
Detroit	Quantity not established	Maintenance: Silt, sand, clay, gravel New Work: Silt, sand, clay, gravel, rock	Island Upland	100-200	Sites separated from populated areas by water
Chicago	Quantity not established	Sand, silt, clay, sludge	Riparian Island	Not available	Sites both remote and near industrial areas
Mobile	Quantity not established	Silt, mud, sand	Riparian	Usually 50-100	Some sites on or near residential areas
New Orleans	20	Silt, sand, clay	Riparian	20-300	Remote
Galveston	8.7	Silt, sand, clay	Island Riparian	Not Available	Sites both remote and near residential areas
Seattle	0.5	Sand, silt	Riparian	20-150	Sites both remote and near industrial areas
Portland	2	Sand, silt, rock	Riparian	50-300	Some near residential areas
Sacramento	0.75	Sand	Upland, Riparian	60-250	Near residential areas

SOURCE: Arthur D. Little, Inc., files.

Access to island sites is usually limited to water transportation. The riparian areas adjacent to shore also may have little to no accessibility. These types of sites are often constructed with equipment located in the water, with no road access necessary. The longer range disposal areas that require maintenance for dike stability and weir operation may have access incorporated into design. Those areas which are designed to accommodate more limited dredging operations usually will have no access. Access is generally available to all upland sites because of construction methods.

Although no surveys have been done on access to disposal areas, an estimate (based on limited field visits) would be that half of all disposal areas have some road access. Lack of access means generally that the area surrounding the disposal area has not been developed; for example, it is marshland or lowland forest.

Most riparian areas closest to dredging operations are located in wetlands. Environmental concerns have prompted the Corps of Engineers to restrict use of wetland areas for disposal. As a result there appears to be a trend in some Districts to locate dredged material inland to fill in the low areas of terrain. These areas usually have good access.

5. Inundation

Inundation occurs when tides, storms, flooding, or other natural occurrences cause waters to flow over the dikes into the disposal areas. Inundation is most likely to occur in short-term disposal sites where the dikes are low. Inundation is followed by a period of

standing water until the water can drain from the disposal area. Often, however, the forces which cause inundation in these short-term disposal areas will cause dike failures. In this case, the material confined within the disposal site may be lost to the surrounding waters if it has not drained. In a site with relatively dried material, such as an inactive site, dike failure would make the interior of the dike subject to repeated inundation and possible damage.

CHAPTER III: THE HORTICULTURAL INDUSTRY

A. GENERAL INFORMATION*

Horticulture, as it is defined under common usage, is that part of agriculture concerned with garden crops. This definition includes fruits, vegetables, flowers, and ornamentals, as well as spices and medicinals. Intensity of cultivation is a common characteristic of horticultural production. Horticultural crops are usually of high enough value to warrant a large input of capital, labor, and technology per unit area of land.

This study is confined to nonfood horticultural crops. Within this category are included nursery products (woody and nonwoody ornamentals), lawn sod, foliage plants, Christmas trees, and vegetable and flower seeds and bulbs. The definition of horticultural crops, as used in this study, will encompass only these products.

The production of horticultural crops is widely dispersed throughout the U.S. However, production is concentrated in the coastal regions and near major metropolitan areas (see Figures 1 and 2). This concentration, as will be discussed in later sections, is due to climatic constraints or marketing restrictions for the production of a certain number of these crops.

*For a detailed discussion of the horticultural industry, see Jules Janick, "Horticultural Science," W. E. Freeman and Company, San Francisco, 1972 (reference 38).

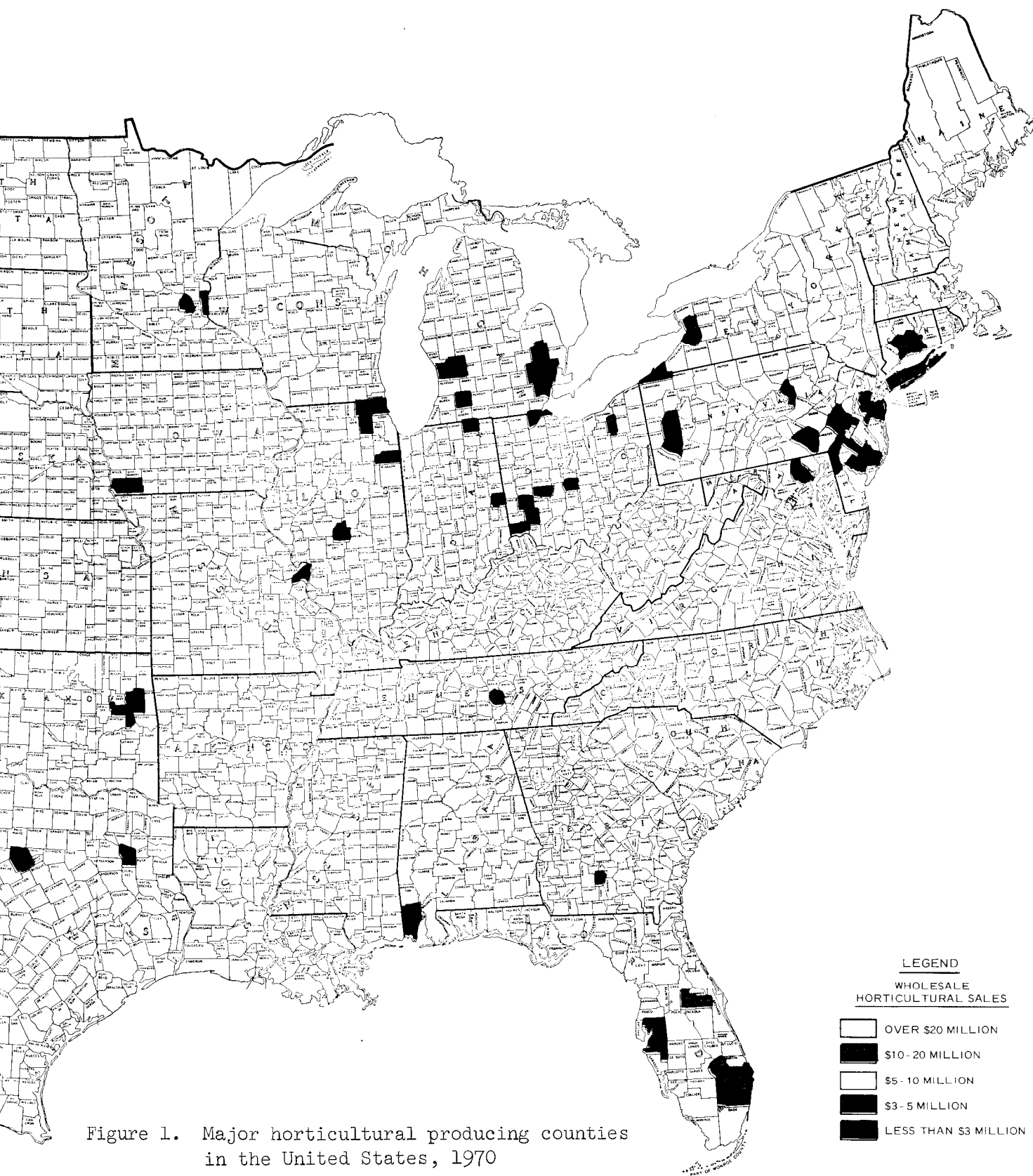
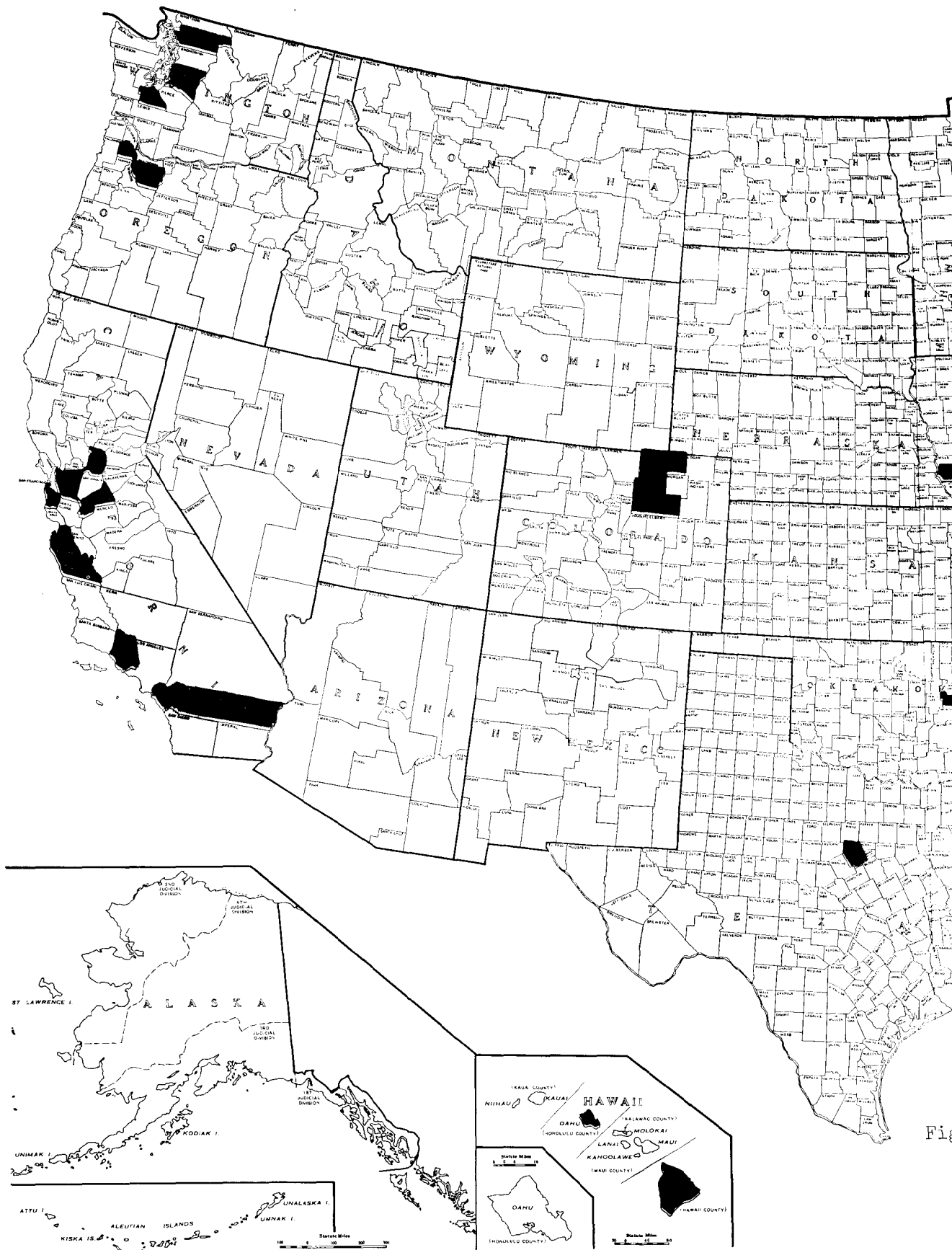


Figure 1. Major horticultural producing counties in the United States, 1970

Source: U. S. Dept. of Commerce 1969
 Census of Agriculture and
 U. S. Dept. of Agriculture



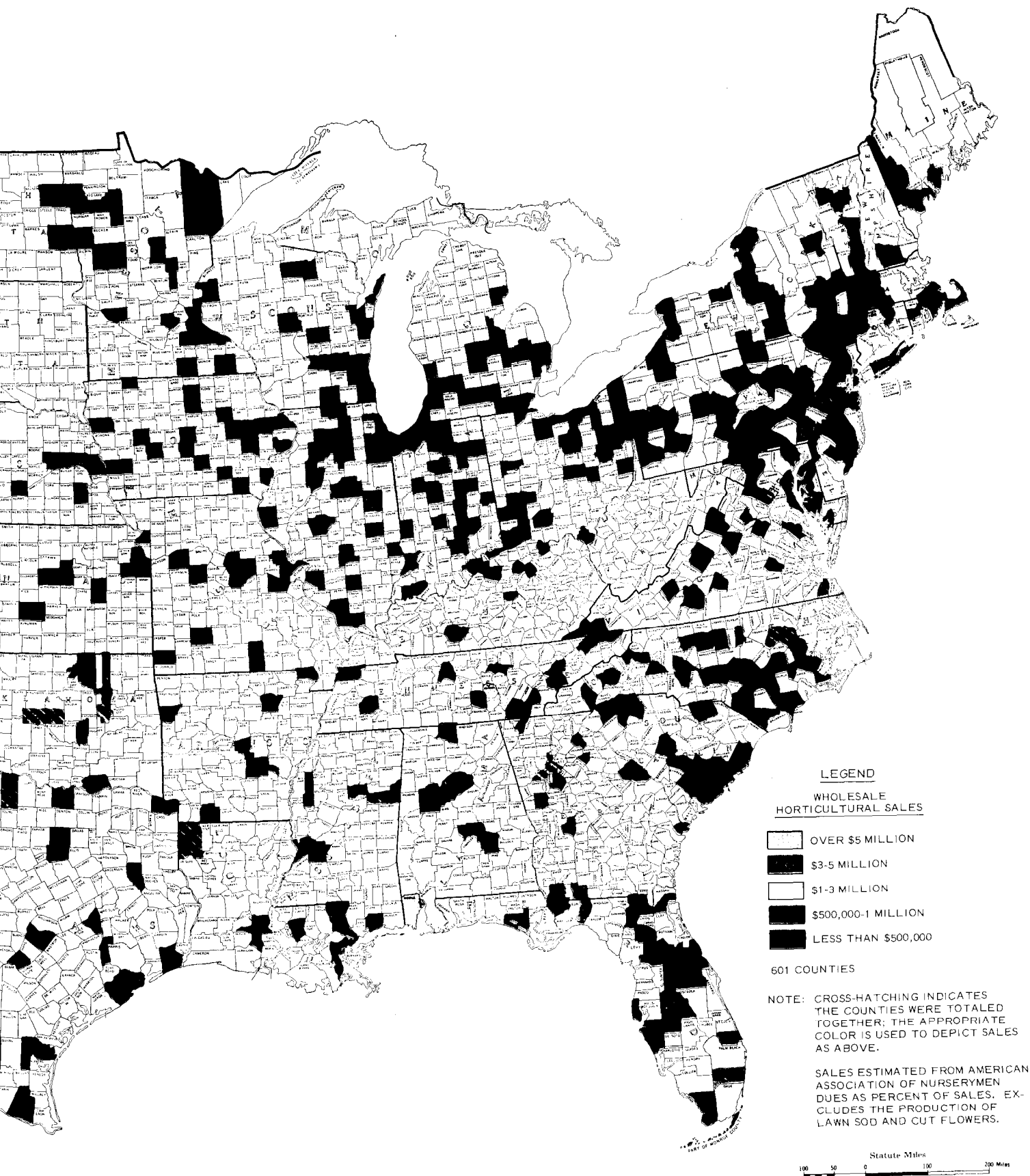
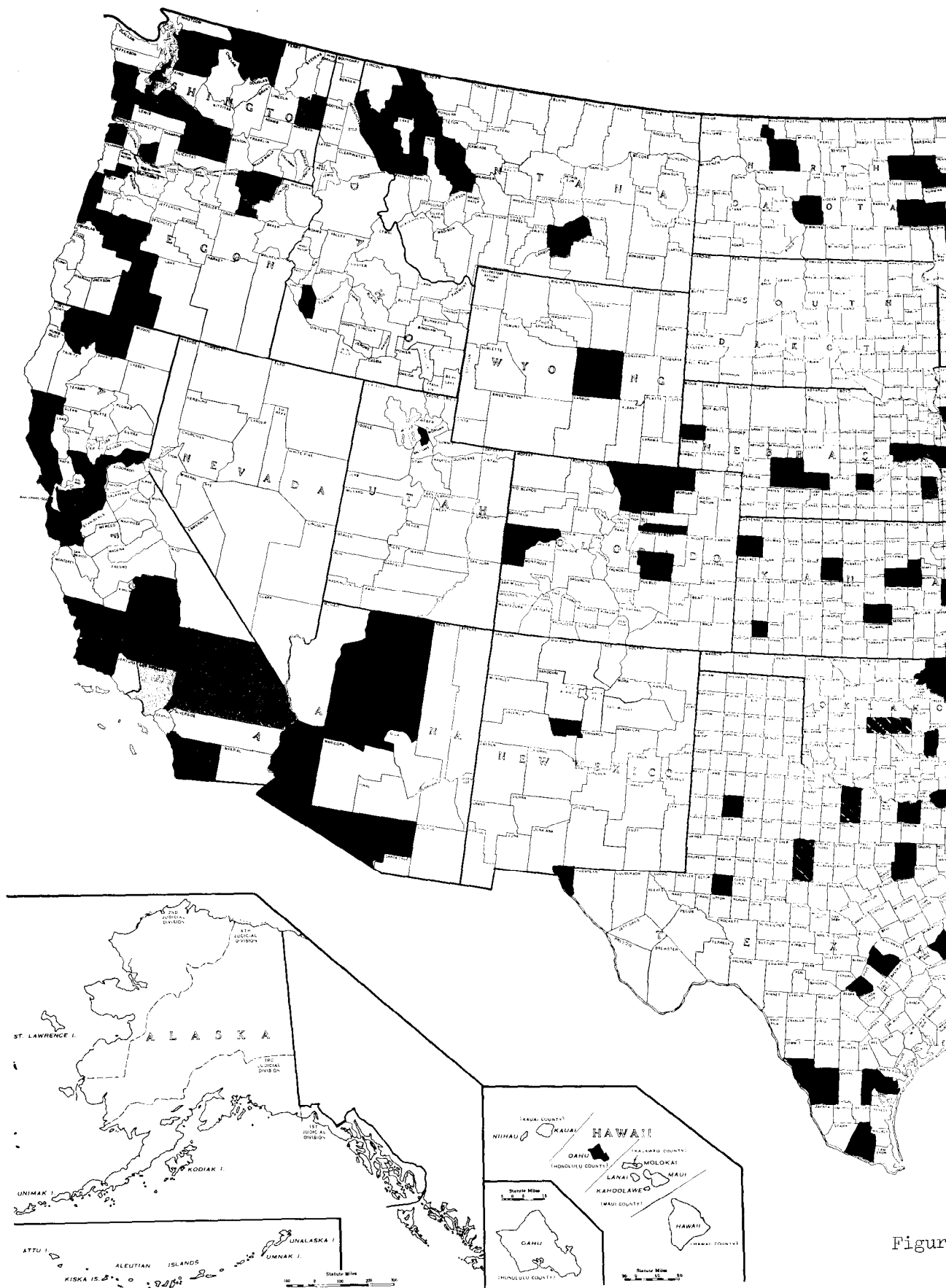


Figure 2. Geographic distribution of major horticultural producing counties in the United States, 1973



B. NURSERY PRODUCTS

1. Woody Plants and Ornamental Shrubs

Deciduous and evergreen shade trees and all conifers, broad-leaf evergreen, and deciduous shrubs as well as numerous ornamental landscaping plants are included in this category. For the most part, the plants are field-grown in the approximate areas where they are to be used. Their ability to resist damage from freezing weather determines where they will be permanently planted, but propagation and intermediate growing can be done over a much broader range of temperatures as long as it is on the warmer side; that is, roses that are hardy in the most northern states may be propagated and field grown to maturity in warmer climates with a much longer growing season. Many ornamental landscaping shrubs are grown in California and shipped to eastern markets. This is ostensibly possible and profitable because the longer growing season reduces the cost of production enough to overcome the higher shipping costs.

2. Cut Flowers

The most popular species of cut flowers grown and marketed commercially are carnations, chrysanthemums, roses, gladioli, and daisies, although many other varieties are produced and marketed on a smaller scale. Unlike the woody plants and ornamentals which are grown all over the country and reasonably close to their ultimate markets, the cut flower production is concentrated in only a few areas. For example, carnations are concentrated in Colorado and gladioli in Florida and California, and more than 50 percent of all cut flowers are produced in California, Florida, Pennsylvania, Colorado, and New York.

Such concentration of growing, making best use of optimum growing conditions, is possible because the cut flowers are lightweight and can readily be shipped by air freight. The air shipments have been considered for many years as a vital part of the distribution pattern of cut flowers. In the last few months, however, higher air freight rates and cubage limitations have forced the growers to consider alternative methods of shipment to keep their costs down. There is renewed interest in refrigerated trucks. There is also expansion of the bud-cutting technique whereby the flowers are cut in the final bud stage, shipped in the tightest density possible for the variety, and then placed in water at elevated temperatures to bloom. This has been most successful for gladioli and chrysanthemums.

Considerable quantities of cut and potted flowers are grown in many other parts of the country in greenhouse conditions. However, the lower cost plastic shelters and support facilities of the growers in California and Florida make it difficult for other states to be competitive, despite the higher shipping costs incurred by California and Florida.

3. Bedding Plants

Geraniums are by far the leader in this category, which is growing at a very rapid rate. Bedding plants are used for outdoor plantings in borders or for mass plantings. They are typically propagated and used as annuals, though they may not always be propagated from seed. The geraniums are usually propagated from cuttings

on an annual basis, but other semitropical plants of a similar nature are more readily reproduced from seed.

The bedding plants are typically grown in a rather heavy growing medium with at least a one-third soil content. The plants are grown in open flats, without provision for long-distance shipments. Generally, distribution of bedding plants is on a very regionalized basis with wholesale greenhouse production taking place in every part of the country.

C. FOLIAGE PLANTS

The growing of nonflowering tropical foliage plants for use as interior decoration in homes and offices has, until very recently, been highly concentrated in Florida. However, with rising shipping costs and the ready availability of cuttings which are readily rooted and grown in small pots for the retail market, more and more florists are growing their own plants in greenhouse facilities adjoining their retail stores. There are many sizeable greenhouse producers of tropical foliage plants throughout the country, but they usually limit themselves to producing only the most common and easily propagated varieties.

About 50 percent of these plants are still grown in Florida where the clear air, along with abundant and strong sunlight, permits as many as five crops a year in the technically advanced glass and plastic houses. Much parent stock, from which the cuttings are derived, can be field grown on the premises; although, because of the

broad range of plants being grown, many of the cuttings originate in the Caribbean and in Central America. The density of these greenhouse operations is such that the foliage plant production is occasionally valued at one million dollars per acre per year.⁽²⁾

D. LAWN TURF

The type of sod grown varies in different parts of the country as do the growing and harvesting techniques. Commercial turf production is a rather young industry, originating after World War II. Somewhat rigid controls on the quality of several different type of sod have been developed, primarily through the intensive efforts of university agricultural colleges in New Jersey, Virginia, Michigan, and Indiana. These developments are being strengthened and promulgated by the American Sod Producers Association, which was formed in 1967. An estimated 50 percent of the sod producers, representing an estimated 80 percent of the total production, are members of the association.⁽⁴⁾

E. CHRISTMAS TREES

Plantation growing of Christmas trees is an increasingly popular method of supplying the desires of U. S. consumers for natural ever-green for holiday decoration. Christmas tree farms are found in every state in the U.S., although the species produced vary regionally because of consumer preferences and the growing requirements of various species.

CHAPTER IV: HORTICULTURAL PRODUCTION

A. INTRODUCTION

Horticultural crops, as other agricultural crops, are not grown in short-run production cycles, but rather as part of a long-term commercial program developed by the producer. Decisions on cultural practices are made not only on the basis of profitability of the current year's crop but also take into consideration long-range goals and land management practices.

The diversity of the horticultural crops considered in this study is manifested in a diversity of the production techniques, cultural requirements, and capital investment typical for these crops. Within this chapter the major issues concerning production organization and techniques for each crop will be discussed. The discussion will be limited to those factors which potentially impact horticultural production on dredged material disposal sites.

B. FOLIAGE PLANTS

The foliage plant segment of horticulture is unique because it depends very heavily on growing under greenhouse conditions plants which, being tropical in nature and origin, are not successfully propagated in ambient conditions in the United States. Though some parent plant stock is cultivated under carefully controlled conditions in

Florida, most cuttings are brought into the continental United States from Puerto Rico, Central America, and South America.

The cultivation of foliage plants is also unique because of the density of planting, with a capability of growing up to one million dollars worth of annual production per acre of glass (or plastic) houses.

1. Where Foliage Plants are Grown

Foliage plant growers in twenty-three states (see Figure 2) had 38.8 million sq ft of greenhouse production in 1972, up six percent from 1971. Florida was the leading producer of foliage plants, with 31 million sq ft in production, or 80 percent of the total for the twenty-three states. California was second with 2.5 million sq ft, and Texas was third with 1.7 million. These three states accounted for 91 percent of the total net value of sales. Intended area in production for the twenty-three states in 1973 was expected to be about four percent more than in 1972.

The remaining nine percent of production was grown in smaller greenhouses by florists and garden centers operating retail establishments.

Florida is the largest producer of foliage plants for several reasons. The primary reasons are climate and clear air. The sunlight in Florida is very intense and, when combined with artificial shading and humidity conditions, comes closest to the natural environment of the tropical plants. Growth is so efficient that the propagation beds are turned over five times a year for most products.

Production has also been expanding in Florida because it is the traditional center of marketing. Buyers for the large chain store operations can purchase their complete requirements in one general location. If one particular grower does not have a desired variety, the buyer can go to another grower, often in the same town, and get what he wants.

The concentration of foliage plant growers in Florida does not preclude expansion of the industry into the coastal areas of the Gulf States. Louisiana is becoming a significant producer and other areas that are relatively free of frost in the winter months are areas of potential expansion. Some progressive growers indicate an interest in having remote locations because of the danger of storm damage to their operations. As long as the headquarters are centered in Florida for ease in selling, it makes little difference where the plants are actually shipped from.

Most producers have developed rather sizeable businesses capable of having their own sales and market managers. As they develop their ability to go to the market, rather than have the buyers come to them, there will be less need to continue concentrating production in Florida.

Nevertheless, there are some compelling reasons for the area south of Miami to continue producing tropical foliage plants as well as tropical trees and shrubs. First, they can often be grown in

the open field, because the temperature never goes below freezing. Second, the overall temperature is conducive to the production of certain varieties that cannot be grown commercially elsewhere. An example of this is the type of indoor landscaping shrubbery so popular for shopping malls and office buildings in the northern states. These are field grown in southern Florida. When the plants reach the desired maturity, they are containerized and sold to growers in the north-central part of Florida where they are conditioned to the lower candlepower of indoor growing. Subjected to the shade of lath houses, the leaves fall off but new ones quickly follow and these mature under very carefully controlled lighting, similar to that existing in the end-market locations. This line of merchandise is considered very high value and is shipped to all parts of the U.S. with little regard for the weight of the container and growing medium.

2. The Techniques of Propagation

The business of growing foliage plants is essentially one of propagation. The cuttings or seeds are put into a rooting or growing medium from which they are transplanted to small pots and almost immediately shipped to the marketplace.

Most of the growing media is manufactured. One of the more common media mixes contains equal parts of decayed bark mulch, peat moss, and pure silica sand which is combined in a large cement-type mixer and then is sterilized by low-temperature steam. The pure silica sand in the growing medium serves as an abrasive material to promote quick rooting of the cuttings. When grown under greenhouse

conditions, overhead jets automatically give off a fine mist of water to keep the humidity in the propagation areas as high as possible while keeping the actual leaves wet. This system best simulates the natural tropical conditions for the plants.

While the hot direct sun of Florida is ideal for tropical plant growth, it also causes excessive heat conditions in the glass houses. The houses are equipped with evaporative cooling, having water-sprayed filters on one side of the building with large fans on the opposite side pulling the air into the building and exhausting it on the fan side. In less critical areas, simple exhaust fans are used for cooling.

3. The Finished Product

The rooted cuttings or seedlings are potted in minimum-sized pots in a growing medium similar to the propagation soil, except that some nutrients may have been added. The plants are stored for shipment in ideal growing conditions, either under glass or in lath houses.

Well-designed shipping containers protect the potted plants during distribution. Since the demand for house plants has been growing steadily, the growers have become increasingly promotion- and market-conscious; for example, Mother's Day, Father's Day, or Valentine's Day may be the occasion for brightly-colored pots or a joint promotion with other store merchandise of the customer's choosing.

Most house plants are shipped by air. A lightweight growing medium is a decided asset when using air shipment. Because of rising air freight costs, interest in truck shipments is growing, and some of the large growers are beginning to send full-truck quantities to major metropolitan areas.

C. LAWN SOD

Within the past fifteen years, the commercial lawn sod industry has developed into a specialized, highly technical, and increasingly important sector of the agricultural economy. Historically, pasture or field sod cut from existing fields was the major source of sod for lawns. But the development of machinery, management practices, and improved seed varieties in conjunction with greatly increased demand for uniform, high-quality turf has led to the present industry structure. It is estimated that 1000 commercial producers are now active in the sod market in the United States.⁽⁴⁾

These lawn sod producers have under cultivation nearly 200,000 acres of turf, an average of 200 acres per operation. It should be noted however that an estimated 55 percent of all producers handle less than 100 acres. Some of these producers utilize sod as a supplementary source of income in conjunction with other agricultural enterprises. The cultivation of larger acreages specializing in lawn sod is an apparent trend.

Sod production in the United States is divided into two distinct sets of operating entities. Northern producers control 70 percent of the sod sold in the United States, primarily Kentucky Bluegrass and other winter hardy varieties. Southern producers control about 30 percent of total production and produce Bermuda, St. Augustine, Zoysia, Bahia, and other primarily vegetatively propagated grasses.

The method of propagation, vegetative sprigs for the southern grasses and seed for Kentucky Bluegrass and other northern varieties, causes considerable variation in sod production between the two areas of the United States. Southern producers establish a sod field from sprigs of approved turf varieties. At harvest a ribbon of sod is normally left between each cut of the harvesting machine. This ribbon then becomes the parent stock for the succeeding crop. Once established, a sod field in the southern United States may produce crops for up to fifteen years. The seed-propagated varieties grown in the northern States must be reseeded following sod removal.

Aside from crop establishment practices, cultural practices are quite similar throughout the United States. Large commercial sod operations now rely heavily on vigorous grading and leveling of production sites in order that sod can be harvested in accordance with the thickness standards established by the American Sod

Producers Association and other groups. Care in leveling also facilitates mowing, irrigating, and draining the production sites. Many larger producers own scrapers, blades, and land-leveling machines, while others rely on contractors for grading and leveling operations.

Weed control is important to sod producers. The standards of the American Sod Producers Association state that "cultivated sod shall be free of objectionable grassy and broad leaf weeds. Sod shall be considered free of such weeds if less than five such plants are found per one hundred square feet of area. Sod will not be acceptable if it contains any of the following weeds: wire grass, quack grass, Johnson grass, poison ivy, nuts edge, nimblewill, Canadian thistle, bindweed, wild garlic, ground ivy, perennial sorrel and brome grass." Obviously, these standards entail a rigorous weed control program by the producer.

Control of the grassy weeds is especially difficult after sod production has begun. Some producers will grow row crops (soya, corn, etc.) for up to two years before sod establishment in order to facilitate control of grassy weeds. Some sod producers in California use fumigation at a cost of \$300 to \$500 an acre to rid the soil of weeds and (30,34) bacteria. Following sod establishment, herbicides are used to control broad-leafed weeds.

Irrigation, especially during initial establishment of the crop, is considered essential to the successful commercial sod operation. During the growing season irrigation is not heavy because

somewhat drier conditions appear to encourage more extensive root growth. Irrigation is also carried out just prior to harvest to improve appearance. Aside from crop establishment, however, irrigation is essential mainly as insurance against hot or dry conditions which might damage this high-value crop.

All types of irrigation systems, including subsurface, spray gun, rolling sprinkler, canal, and solid-set sprinkler, can be found on sod farms. Solid-set sprinklers appear to be growing in popularity because of the labor savings realized from these systems.

Soil quality needs for sod production appear to be relatively simple. Growers and research workers characterize sod as a very tough, adaptive crop and feel that through use of proper soil amendments most soil deficiencies can be corrected. However, saline soils are not usually recommended for sod production.

Soil texture is an important consideration. Organic soils with a silty texture are regarded as optimum for sod production. In these soils a tight-knit turf can be formed two to four months faster than in a sandy soil. However, in terms of overall quality, sod from soils of different texture appears to be equal.

The normal production period for sod is eight to twelve months, although this period may vary greatly between different climatic regions. While southern producers may essentially harvest year round, Minnesota growers may be limited to a four-month harvest season. Some producers may be able to shorten the production cycle to six months, but this is presently the exception. A new technique,

utilizing plastic netting to speed turf development, promises to allow production in four months, but this technology is presently in its infancy. Also, this netting technique evidently involves even more rigorous land-grading and leveling practices than is normally necessary.

Sod harvest requires both flexibility and the ability to harvest quickly on the part of the grower. Often because of construction or other delays, delivery must be postponed for weeks. However, when delivery is made, action must be swift. Cut sod is a highly perishable commodity. Standards dictate that sod must be transplanted within thirty-six hours of the time it is cut. Thus, within this thirty-six hour period, the sod must be cut, rolled, loaded, hauled, off-loaded, and transplanted. This factor of perishability and the cost of transportation are the reasons why producers typically market within a 200-mile radius, and never more than 400 miles.

Sod transportation has continued to be costly, even given that producers are now shipping less soil with the sod by harvesting the sod at a depth of only one-half inch as opposed to one to two inches in the past. Therefore, sod producers are very concerned about location within a strong local market and with maintaining and developing this local market. To illustrate the importance of transportation charges, consider the following set of representative 1974 sod hauling charges:

<u>Haul Radius</u> (Miles)	<u>Cost</u> (Cents/sq yd)
50	14.5
75	17.5
100	21.5
125	24.5

(cont.)

<u>Haul Radius</u> (Miles)	<u>Cost</u> Cents/sq yd)
150	28.0
175	30.5

Source: Arthur D. Little, Inc.

Given a typical wholesale price of \$0.75 per sq yd at the farm and a typical hauling radius of 75 to 100 miles, transportation charges would equal 22% of delivered price. Obviously, then, a production location close to a market would increase the producer's profits or improve his competitive position.

Palletted sod is hauled on trucks which carry up to 1200 sq yd of sod per load. Use of this equipment requires good access roads to the production area.

In summary, sod production is evolving into a sophisticated business; however, it requires heavy capital investment, high labor requirements, and strict management practices. The successful sod producers appear willing and able to expand both in their present locations and at new remote sites. Sod production on a commercial scale (100 acres or more) is evidently quite profitable. Producers are willing to pay as much as \$1000 per acre or more for good land, suitably located. On a lease basis, typical annual rents are presently \$75 to \$100 per acre but may be as high as \$200.

D. NURSERY PRODUCTS

The nursery industry went through a very desultory period following World War II. In spite of a great housing and general building boom, there was little interest on the part of the industry to expand to meet the tremendous demand and few newcomers were

interested in entering the field of growing nursery stock. It should be noted, however, that a substantial growth took place between 1949 and 1959, especially in the final four to five years.

In the early 1960's the nursery segment of the industry enjoyed a rebirth. Hundreds of new nurseries came into being and others were expanded. But the lack of growth in the industry during the previous twenty years meant that supply was unable to meet increasing demand; in other words, supply had always lagged far behind demand. Some industry experts indicate that supply is still approximately 20 to 30 percent behind demand. A sampling of several large regional wholesale nursery growers indicated that for the last several years the entire crop has been committed before harvest, even though their production and efficiency have steadily increased, along with substantially improved quality.

The greater growth period became the time for increased specialization and segmentation of the industry. More producers began growing conifer seedlings, broadleaf evergreens, or deciduous tree and shrub seedlings. With great overlapping, in a truly entrepreneurial oriented business, some propagators retained portions of their seedlings or rooted cuttings for production of mature stock for wholesale supply to the retail industry, while they occasionally carried out a small and rather localized retail operation of their own. The large wholesale growers who purchased most of their liner stock would also propagate by cuttings, seedlings, or grafting some special varieties and might carry on a small retail or mail-order business.

1. Requirements of the Nursery

The basic requirements for successful nursery production are: a) good, deep, farm type soil; b) an abundant supply of fresh water; and c) a source of inexpensive labor. It is also necessary to have sufficient capital resources to permit an extremely unbalanced flow of cash to support labor and materials costs for an entire year while income is limited to only three to four months.

a. The Soil

Nurseries are usually found on land that has been backyard gardens, truck gardens supplying nearby communities with vegetables, or small farms close to cities and towns. In the last two decades the nurseries have moved farther away from the cities as the land became too valuable to be used for field-grown crops and as distribution systems have permitted economical transport to city and suburban customers. The most basic feature of these growing sites is the nature of the soil. It will be deep and rich from years of cultivation and it will be located in an area that is sufficiently protected by zoning and other land use regulations to permit a long-term commitment to the production of nursery products. The land will be relatively flat and well-drained for easy maintenance with mechanized equipment.

The recent trend of growing nursery products in metal and plastic containers makes it less necessary to have the traditional deep growing medium. Often, for easier weed control among the containerized plants, black polyethylene is laid over the ground. The containers are designed for excellent drainage, and though they require

more frequent watering than regular field-grown crops, the system offers the significant labor advantages discussed below.

The growing medium in the containers is carefully controlled and usually prepared similar to potting soils. A common mix is one-third loam (or local soil), one-third sand, and one-third peat moss or other humus. In most cases this mixture will be either steam or chemically sterilized to remove undesirable bacteria, fungus, and weed seeds. In nursery growing of the very expensive indoor ornamental shrubs and trees, the soil will always be sterilized. Such a growing medium has the advantage of being very light in weight for less costly transportation and ease in handling, but may have the disadvantage of containing low nutrients and will consequently require regular feeding.

Conifers and most broadleaf evergreens, as well as many deciduous ornamentals, require a slightly acid soil. Consequently, these products are best grown in those areas of the country having naturally acid soils. The consumers who plant these ornamentals throughout the country may be required to adjust the pH of their soils accordingly. Most plants have a natural ability to grow in soils that approximate a neutral pH and the above-mentioned plants will survive in soils that are not obviously alkaline.

Certain salts and minerals in the soils will be harmful to the production of premium quality nursery stock. Growers would not be expected to use land that had not been carefully tested in a laboratory or at least by the successful growing of various farm

crops. It is possible to plant a field in nursery products if it has recently supported farm crops. However, after nursery crops have occupied an area for five to seven years, the land is usually restored by planting one cover crop which is turned under, followed by a grain crop which is grown for profit. If the latter is wheat or oats, it will be harvested in midyear, permitting the soil to be prepared to receive liner stock for a new growing cycle in the Fall.

b. Water Supplies

An abundant supply of fresh water is even more vital to nursery growing than good soil. As has been demonstrated, the lack of good soil can be circumvented by growing in containers in a manufactured growing medium. However, all plants must have a constant supply of water to sustain an even and healthy growth rate. Lack of water not only will retard the development of the plants in a crop that is already severely limited by time, but could damage the quality severely.

The first requirement, then, is to establish a source of water from a municipal system, wells dug on the premises, or reservoirs made by tapping or damming streams. Stationary or portable pumps will bring the water through elaborate piping and sprinkler systems to every portion of the growing, handling, and shipping areas. Some shipping sheds are even equipped with sprinkler heads that send a fine mist of water over the nursery stock after it is loaded on the trucks for transport to market.

In this labor-intensive operation, most growers will strive to have some type of permanent irrigation system installed

which will not require personnel to continually move pipes and hoses. Elaborate systems of metal and plastic pipes will service the fields and most growers will put them underground to prevent damage during the mechanized nursery maintenance operations. Since the pipes will be drained to prevent damage during winter freezes, the overall grades of the terrain are obviously of considerable importance.

c. Labor

Historically, the cost of nursery stock was basically determined by time and labor. This has become less true in recent years as the use of chemicals and fertilizers, as well as a high degree of mechanization, has come to characterize nursery growing. However, every operation still requires considerable manual labor. Preparing cuttings, transplanting cuttings or seedlings, weeding, pruning, potting, and harvesting the field-grown crops are all operations which depend on the skills of manual labor. Though they are somewhat simple skills, the quality and profitability of an entire crop will depend on how well these basic operations have been handled. The jobs are, for the most part, dull, repetitive, and boring, and every grower complains that it is difficult to keep qualified help on the job. Absenteeism and employee turnover are constant problems.

Greater mechanization has improved the efficiency of nursery operations, but has not greatly reduced the need for labor. For instance, certain small seedlings lend themselves to planting by machine, but the maintenance, transplanting, and root pruning are all done by hand. The use of trucks and tractors with booms and

winches has made it possible to harvest larger shrubs and trees with ease. But the digging and burlapping must be done by hand. Pots and containers may occasionally be filled with the growing medium by machines, but the planting is still done by hand. When one considers that every plant, shrub, or tree is handled from ten to twenty times by the time it reaches the consumer, it is easy to understand how heavily dependent the nursery industry is on manual labor.

2. Where Nursery Stock is Grown

Although every American community of any size probably has a small nursery or two that grows its own stock, the great bulk of product is grown in a very few states. Figure 2 shows that California is the dominant producer with almost \$70 million of nursery product sales, more than four times the sales volume of Ohio, the next largest producer with \$16.6 million.⁽⁴³⁾ In the next ten largest producing states, the sales volume ranges from only \$8 to \$14 million. Most significant is the expanding growth rate of the industry in every state except California during the decade from 1959 to 1970. Already the single largest producer, California's growth rate was small.

Even more significant is the distribution of the one hundred largest producing counties in the states that lead in producing horticultural specialty crops. Six of the top ten counties and nine out of the top fifteen counties are in California, with counties in Pennsylvania and Florida dominating the balance in the top fifteen.

Figures 1 and 2 clearly indicate the importance of warm climates and the accompanying long growing seasons in the commercial production of nursery stock. Many hardy varieties intended for markets in the northern states are being grown in the warmer climates where they can mature in far less time than in the northern nurseries. The world's largest grower of roses has transferred its field growing operations from upstate New York to Oregon and California for this reason. The savings realized by eliminating winter storm damage and frost kill is substantial in a grafted crop such as hybrid tea roses.

3. Production Organization and Techniques of Propagation

Some ornamental conifers are reproduced from cuttings, but the vast majority of seedlings are propagated from seeds. Demand for these seedlings has become so vast that several firms are specializing by only growing conifer seedlings and producing them by the millions. These may go into conservation and reforestation projects in the public or private sector, into Christmas tree production, or into the wholesale nursery market for production of specimen ornamentals for landscaping.

Most growers who have specialized in propagation will not limit themselves to conifer seedlings. They will also produce ornamental evergreens and broadleaf evergreens from cuttings and probably include in their product mix a variety of shade trees grown from seed. They may also produce a variety of hardy plants to be used for root stock in grafting specialized varieties of flowering and nonflowering trees.

As the hundreds of thousands of seedlings are thinned and transplanted, they are offered to the wholesale nursery growers as one-, two-, or three-year plants that may have been transplanted and root pruned once or twice. By the time the plants are five years old, most of them will have been sold to the wholesale growers. More and more of the seedlings will have been transplanted into containers in the increasing trend for the wholesale growers to handle container-grown stock.

The density of product grown by the propagators is intense, creating a high dollar value per acre of planting. As in the growing of foliage plants, great care is taken to prepare the growing areas and water the plants properly. The cutting beds will have timed water misting along with controlled bottom heat; the seedling beds will be watered by systems with automatic timers, leaving very little to chance.

Shipping of the finished product is perhaps the least troublesome for the grower of this type product. The density of product is great and frequently there is no need to ship soil on the cuttings or seedlings.

The intermediate wholesale growers will purchase most of their liner stock from the propagators. This product may be the very young seedlings and cuttings or may be more advanced in size, depending on the nature of the wholesaler's markets. If his growing cycle is in the five- to seven-year range and he is providing specimen shade trees for home or municipal use, he will probably purchase four- to six-foot liners which can be pruned and trained into specimen plants

in that time frame. Accompanying these larger shade trees may be a variety of other plants which are younger but will nevertheless mature to market size in the same field on the five- to seven-year cycle. It is important for efficient use of the growing fields that the harvest take place within a reasonably short time so that big equipment can be utilized to prepare the whole field for the cover crops in preparation for another growing cycle.

The large wholesale growers gear their operations to supplying the retail outlets. The product, if not grown in containers, will be hand dug and the root ball wrapped in burlap. Since most crops are contract sold before they are even ready for harvest, the preparation of orders is handled according to the delivery schedules. The product is ordinarily palletized on wooden pallets which can be handled by fork-lift trucks and loaded on captive carriers which will transport within a one hundred to four hundred mile radius. Because the stock has been carefully root pruned during its growth period, the root balls have a very high concentration of hair roots and the balled and burlapped unit will have the capability of being shipped long distances and displayed at the retail outlets for considerable periods with only normal watering.

In the large urban and suburban areas, the retail nurseries tend to rely on selling the balled and burlapped stock very much as it arrives from the wholesale growers. Of course, literally thousands of small nurseries have their own growing facilities and will be able to place unsold stock in the fields where it can continue to

mature and increase in value with only minimal care such as watering and occasional pruning. These retailers will also have considerable stock which they have purchased from the propagators in various sizes for finishing and sale directly to the consumer.

E. CHRISTMAS TREE PRODUCTION

Plantation Christmas tree production, in contrast to the other crops which have been studied, has a relatively simple production organization, entails a lengthy cash flow period, and returns a relatively low value per acre. Christmas tree production is carried out in every State, often utilizing low value, otherwise unproductive land.

An estimated 15,000 plantation growers presently control over 450,000 planted acres of conifers for Christmas trees.⁽¹⁹⁾ To a majority of these growers, Christmas trees represent a sideline or hobby income. However, a number of growers have up to 1,000 acres of trees under cultivation, and one tree grower is reported to control nearly 30,000 acres.

The production period for Christmas trees varies by species. The rotations for Scotch Pine and Douglas Fir, the two most popular trees, average nine and eighteen years respectively. This differential is reflected in the producers' price, which is presently about \$2.50 per seven-foot tree for Scotch Pine and \$4.00 per seven-foot tree for Douglas Fir.⁽³⁵⁾ The first returns from tree sales may be received as early as the sixth year from Scotch Pine, at which time one-third of the trees are cut and sold. First sales of Douglas Fir will not occur until the twelfth year, at which time one-sixth of the trees will be cut and sold.

Comparing returns over an 18-year period, average annual net income per acre is relatively similar for Scotch Pine and Douglas Fir, reported to average \$105.00 and \$130.00 per year, respectively, under good management. Other species tend to show lower annual returns per acre, dropping to \$60.00 for some species.⁽³⁵⁾

Critical environmental conditions for Christmas tree production include: 1) light, well-drained soil; 2) good air drainage; and 3) neutral or slightly acid soil. Sand is the preferred growing media. The trees are planted in checkerboard patterns of five by five or six by six feet, equivalent to a planting rate of 1200 to 1750 trees per acre. Planting rate is, again, dependent on species.

Mechanized planters are the most common method of planting; although in small acreages, seedlings are still hand set. Cultural practices are relatively simple. Weed control is critical for the first two to four years of growth, after which the trees are able to compete with the weeds. Weeds are controlled by both chemical treatment (usually only for one to two years) and mowing. Fertilizer and fertilizer application may be a major expenditure for certain areas and species, often accounting for ten percent of total costs for the production rotation.

Another significant cost item is shearing (shaping) of the trees, which involves extensive hand labor. This operation must be performed from three to five times during the production cycle.

Transportation costs, and therefore location, do not form a major item of expenditure for the Christmas tree producer. The trees are a light, easily transportable item in their harvested and bound

state. Transportation of trees from three hundred to five hundred miles is common with transportation charges for hauls of this distance averaging less than five percent of delivered price.

Plantation Christmas tree farmers are not willing to purchase or rent land for prices approaching those of other crops discussed in this study because of the following factors.

- . Proportionately low transportation costs.
- . Ability to use land not suited for other agricultural production.
- . Relatively low returns per acre.
- . Long payout period.

Purchase prices of over \$100 per acre or annual lease prices greater than \$15 per acre would probably not be feasible for plantation growers.

F. VEGETABLE SEED, FLOWER SEED, AND BULB PRODUCTION

These crops, because of the large research investment inherent in their development, are extremely valuable to their owners, the seed companies. Thus, they are grown only under the most rigorous conditions and making use of the best available technology. These crops are too valuable to risk on land not possessing proven production capabilities, and, in the case of contract growing of vegetable seeds, proven owner management capabilities.

Furthermore, capability for handling these seeds after production is well established, primarily in the Pacific Northwest and on the West Coast.

The factors cited above, derived from discussion with major seed companies, were found to be sufficient cause to discontinue study of production of these crops on disposal sites.

A. INTRODUCTION

The escalating growth in the market for horticultural crops has given rise to changes in the product mix of growers, in the distribution channels employed, and in the retail outlets through which these crops are sold. The industry is becoming more sophisticated and more rationalized as corporations grow and as more efficient methods of operation are employed.

This chapter analyzes these changes and identifies the market pressures that will further affect the industry.

B. DIMENSIONS OF THE U.S. MARKET (43,49)

The production value of horticultural crops has quadrupled over the (43,49) past 25 years. The U.S. Department of Agriculture (USDA) estimates the value of horticultural crops has increased from \$270 million in 1949 to \$1,050 million in 1974, an annual growth rate of almost 6 percent from 1949 to 1974. There is a strong suspicion, furthermore, that the dollar value of nursery products is underestimated by the USDA and Bureau of Census data. It is impossible to substantiate whether the data are, in fact, understated. If so, this only strengthens the conclusion that the industry is growing very rapidly.

The growth rates for horticultural products are strongly correlated with the growth of disposable income over the same period. This fact leads many industry observers to the hypothesis that horticultural products are not considered necessities by the consumer.

In recent years, the emphasis on the quality of life in the United States and the increasing concern over the ecological balance between man and plant life have assisted producers in expanding the market for horticultural crops. In the past, plants were bought only on a special occasion; today it is not uncommon for plant purchases to be made on a weekly or monthly basis to decorate a home. A potential problem, however, is the effect of a contraction of disposable income on the ornamental crop industry. Some authorities believe a decrease in disposable income will be reflected directly in a concomitant reduction in demand. Other experts believe a decrease in disposable income will have no effect on the market for ornamentals because consumers have come to enjoy the sight of living plants or flowers in their surroundings and thus will be reluctant to change their consumption patterns or life styles.

The actual effect of any reduced level of disposable income probably lies somewhere between these two views--a continued but lower rate of growth.

C. NURSERY AND FOLIAGE PRODUCTS^(43,49)

1. Nonwoody Ornamental (Flowering, Bedding, and Foliage)

The production value for nonwoody ornamentals has increased from \$109 million in 1949 to \$634 million in 1974. This represents an average annual compounded growth of about 5.5 percent. This group of products is the largest of those under consideration and has demonstrated one of the most attractive growth rates, in part, because of the group's broad con-

sumer appeal. A consumer need not own a house in order to purchase non-woody ornamentals. Consequently, apartment dwellers, an increasing segment of the population, are potential buyers of these products. This factor, along with the ecological and decorative aspects of flowers and foliage plants, has promoted the growth of the nonwoody ornamental market and is expected to continue to do so.

The major product classes within the nonwoody ornamental group are: cut flowers, with sales of \$280 million in 1974; potted flowering plants, with sales of \$174 million; bedding plants and root cuttings at \$110 million; and potted foliage plants at \$55 million. Although all of these products have higher dollar sales than in 1949, they still hold the same general positions and shares of the market, with the exception of potted plants. The potted plants have gained market share in the United States at the expense of cut flowers. Whereas cut flowers accounted for 63 percent of the group in 1949, they have dropped to an estimated 45 percent by 1974. During the same period, potted plants under the impetus of a higher growth rate have increased from 19 to 36 percent of the total market.

The market shares of other product classes have been more stable. For example, foliage cuttings have maintained approximately a 2 percent market share and bedding and root cuttings a 17 percent share despite an increase in the dollar value of sales.

2. Woody Ornamentals

The woody ornamental grouping, which includes lining stock, fruit trees (noncommercial) and ornamentals, has also demonstrated a continued growth of about 6.6 percent per year over the past 25 years (according to USDA data).

This sector of the industry is estimated to have a production value of \$345 million as of 1974. (This figure does not include trees, shrubs, and stock grown by Federal, State, or local municipalities for their own use.)

According to industry sources, growth has been limited by the supplies of stock. The companies in this sector have been too small and often too undercapitalized to tie up capital in stock expansion. However, this situation is changing slowly, as escrow growing becomes more popular.

The product classes in this group are dominated by the woody ornamentals class, i.e., shrubs, etc. These plants have consistently accounted for approximately 80 percent of the product value. Although the dollar volume of other classes, such as fruit trees and lining-out stocks, has continued to increase, the respective shares of production have remained relatively stable at 10 and 5 percent. There are no apparent major shifts expected in market share in the near future. Thus, the woody ornamental class is expected to continue to dominate this grouping. However, it is reasonable to expect an overall continued growth of this grouping as the pressure for beautification of industrial and apartment sites is weighed into the thinking of owners.

D. LAWN SOD

The lawn sod industry has grown dramatically since the early 1960's, at which time the commercial sod industry actually became a viable, self-sustaining agri-industry. The USDA estimated 1965 sod sales to be \$10 million. The Census of Agriculture carried out by the

USDA found that sod sales had increased to \$43 million by 1970, an increase of 330 percent.

As was the case with other horticultural crops, it is commonly observed by industry sources that USDA underestimates sales volume by a factor of at least 100 percent. A 1969 survey of the sod industry by the leading growers found estimated total sales volume at \$100 million.⁽⁵¹⁾ Discussions with industry leaders tend to confirm this higher value. Thus, sod sales in 1973 are estimated to have been \$120 to \$140 million.⁽⁴⁾

The rapid growth of the sod industry is attributed to the growth in U.S. construction activity and the greatly increased penetration of the construction landscaping market by the industry. Eight states produce nearly 70 percent of all U.S. lawn sod.⁽⁵¹⁾ These states--New York, New Jersey, Illinois, Michigan, Wisconsin, Florida, Colorado, and California--are all areas of high population density which have exhibited a high rate of construction activity over the 15-year period of sod industry growth.

Given the concentration of lawn sod sales in the northern United States, it logically follows that the majority of sod produced is of the winter hardy species, mainly Kentucky Bluegrass varieties. An estimated 60 to 65 percent of total sod sales are of the bluegrass varieties with one variety, Merion, accounting for over half of all bluegrass sales.⁽⁵¹⁾ Sod grown for the southern areas of the United States includes varieties of Bermuda, St. Augustine, Zoysia, and Bahia grasses.

Marketing channels for cultivated sod are relatively simple. The major sales outlets for sod producers are landscapers and homeowners.

E. VEGETABLE AND FLOWER SEEDS AND BULBS

Following consideration of the data developed during investigation of the production practices for seed crops, it was deemed unnecessary to study the marketing of vegetable and flower seeds and bulbs.

F. CHRISTMAS TREES

Usage of coniferous trees for holiday decoration in the United States has apparently plateaued with annual consumption now at a level of approximately 35 million trees. These trees had an average wholesale and retail value of \$2.60 and \$6.00, respectively, in 1973.⁽³⁵⁾ Thus, the total value of sales of the wholesale Christmas tree market was about \$90 million, while retail sales volume was nearly \$210 million in 1973. Total usage of natural Christmas trees has increased only slightly since 1964. It appears that this stagnation in growth will continue. However, within the industry, use of the plantation grown Christmas tree (which is grown and harvested in a manner similar to a farm crop) has increased dramatically.

Although Christmas tree plantations have been in existence since the late 1800's, it is only since the 1950's that plantation grown trees have made serious inroads into the marketplace. As late as 1964, only 44 percent of all Christmas trees consumed annually were grown on plantations. The remainder were harvested from wild lands and naturally occurring forests, including a substantial quantity from Canada.

By 1973, however, more than 70 percent of all Christmas trees consumed in the United States were harvested from plantation stands.⁽⁷⁾ With the growth in use of plantation grown trees has come a corresponding decrease

in imports of trees, although some U.S. tree dealers have established plantations in Canada.

The growth of plantation grown Christmas tree usage has been due, in part, to the cost advantages inherent in harvesting and transporting trees from easily accessible growing areas relatively near consumption centers. Probably more important, however, is the ability of the plantation grower to deliver uniformly acceptable trees to meet consumer standards of size, coloration, taper (shape), and density, while also providing the desired species mix.

G. REGIONAL SEGMENTATION OF U.S. MARKET^(25,43)

Because of the perishable nature of horticultural products and the inability of conventional distribution systems to handle those products, horticultural crops traditionally were produced close to the marketplace. However, faster freight delivery systems, both by air transport and over-the-road carriers, coupled with better packaging and handling systems, have begun to bring a change in this traditional regionality. Thus, while regionality of production/marketing still is very much in existence, interregional shipping is encountered in the United States on a fairly regular basis and north-south, east-west shipping is now fairly common with certain product groups. About the only exceptions are woody ornamentals and sod--sod because of its perishability, bulk, and weight, and woody ornamentals because of their size and weight.

This interregional shipping poses a problem in attempting to define regional markets. However, the degree of correlation between

regional production and regional consumption is sufficient to accurately assess regional marketing patterns.

The regional groupings used in this report are shown in Figure 2. These regions reflect the geographical areas that have historically been production/marketing units.

1. Eastern Region

The eastern regional production/market area for horticultural products is one of the major marketing areas in the United States. The southern growing area, primarily Florida, and the heavily populated Northeast Corridor combine to make the eastern region a major factor in the overall U.S. market.

The wholesale values and the growth rate for this region indicate a pattern very similar to that observed in the total U.S. situation. Cut flowers are the most important of the nonwoody ornamentals in terms of dollar value but not in terms of growth. The product value of domestic cut flowers in 1974 is estimated at \$94 million, but its average annual growth rate over the last decade, approximately 2 percent, has not even kept up with the inflationary rate in the United States. Annual purchases of cut flowers have been increasing in excess of 2 percent. However, domestic cut flower producers have been unable to capture a significant portion of this increased demand due to highly competitive products being imported from South and Central America.

The potted plant market, on the other hand, has grown vigorously over the past decade. Potted plants are now one of the most important commodities in the eastern market. Sales of foliage house plants have increased an estimated 14 percent since 1970, indicating a strong demand,

particularly in the northeast. Industry sources believe that supply is inadequate to meet the growing demand. Indeed, the inadequacy of supply is limiting growth.

Sales of bedding plants also have grown substantially over the past two decades, especially in the east where they have met with very favorable consumer acceptance.

Woody ornamentals have continued to be a major product group in the eastern market. The heavy concentration of buildings and population is certainly a key element in this \$97 million market. In addition, woody ornamentals appear to be viewed with more favor in the eastern and western markets than elsewhere in the country. Industry members suggest that in the east with dwelling units often close to each other, the trees and shrubs are found desirable because they act as sound barriers and give a certain degree of privacy.

The outlook for the eastern region is for a continuation of growth particularly in sales of potted plants, cut flowers, and woody ornamentals. This growth will be in response more to higher per capita expenditures and price inflation than to growth in population. Woody ornamentals and house plants are expected to be the leaders in terms of growth and will capture a larger market share in the future.

2. North Central Region

Sales of horticultural products in the north central region of the United States have enjoyed a growth rate of 5.5 to 6 percent per year over the past decade. The value of these products at the grower level has increased from \$78 million in 1949 to \$226 million in 1974.

The north central regional market differs from other regional markets in that all product groupings are growing at about the same 5 to 6 percent rate. Thus, most product groupings are contributing to the total growth.

Among the reasons for the growth in the north central region are population growth, higher levels of disposable income, increased housing starts, and new plant and office facilities. Furthermore, an aggressive floriculture nursery industry has developed in the past 20 years or so, and this industry has helped reduce the reliance on imports from other regions.

The north central region has the potential for further significant growth opportunities, in part, because of population growth but more so because of the emergence of major metropolitan areas. Metropolitan populations are more likely than rural populations to buy ornamental products, in part, because they need to replace the plants that have been removed during the building process. However, industry participants in the north central production/marketing region must also be given credit for helping the market to expand. Some of the more progressive and aggressive grower/marketing firms are found in this region and their continued involvement in the horticultural/nursery business should push further expansion of the market. Ultimately, the demand situation in the north central region will reflect the positive effects of the aggregate of forces at work in this production/marketing area.

3. South Central Region

The south central region is the smallest of the four regions discussed in this report. The total production value of horticultural products in 1974 is only an estimated \$88 million; however, this is approximately

four times the 1949 value of \$22 million. The size of the market and the production in the south central region is not surprising when one considers that this area is the most sparsely populated and has one of the lowest levels of disposable income of those under consideration.

On the more positive side of the picture, sales of ornamental crops have increased significantly in the south central region. The recent increase in production value of nonwoody ornamentals is witness to the fact of the escalating growth in sales of cut flowers and potted plants. There has been a recent surge in production largely because of the favorable climatic conditions and the relatively low cost of inputs. As energy, land, and labor costs spiral upward in other regions, the attractiveness of raising plants in the South increases.

The substantial growth in nonwoody ornamentals is reasonable in light of the favorable attributes of the region--climate and inputs. The woody ornamental sector, however, has not enjoyed the same level of growth although it developed well before the nonwoody ornamental sector. Alabama, Mississippi, Arkansas, and Louisiana continue to be major producers of woody ornamentals, but these products now hold about 50 percent the total market whereas in 1949 they held more than 60 percent.

Much of the production of horticultural products in the south central area is for sale outside the region. The expenditures within a region are tied to growth in population and disposable income, and in this section of the country, both of these demand determinants had been low until the 1970's. The recent industrialization of the south central area should aid in developing a higher level of demand, but only the first stages of this have, so far, been observed. More horticultural crops

are available in this area and, thus, costs are lower. Coupled with the expansion of population and disposable income, the market is expected to grow but at a lower rate than wholesale values due to the continued exportation of product to other regions.

4. Western Region

This region, although not much larger than the south central region in terms of population, has the highest wholesale value for horticultural crops. The wholesale value is not totally representative of the market dimension because of exports to other parts of the country. However, it is indicative of the magnitude of the market and the direction of growth.

Historically, natural geographic boundaries, such as the Rocky Mountains, and distance have isolated the West Coast horticultural crop industry from other parts of the country.

The characteristics of the western region market set it apart from other sections of the country. First, as has been mentioned previously, the western regional market is the largest of the four regions, with an estimated wholesale value of \$324 million in 1974. This is six times as large as the 1949 market when total production amounted to only \$51 million. This remarkable growth rate has been maintained at a fairly steady 7 to 8 percent per year over the past 25 years, whereas other regions, such as the south central, have experienced an escalating but uneven growth rate.

Another differentiating characteristic of the western region is the sizable level of cut flower production and consumption, which, to a large extent, is a result of the climatic conditions of the area and the life styles of the western consumer. It also reflects the availability of products which have been raised close to the marketplace.

Although the growth rates for the various product groupings are thought to be declining somewhat, they must be viewed in the context of a lower rate of population growth, the maturing market, and a much larger value base upon which the growth rate is calculated.

Still another unique aspect of the western regional market is the heavy production and sales of woody ornamentals and the low market share held by potted plants. Here again, the western life style plays a role. Patios or backyards are landscaped and designed for entertainment. Thus, the decoration of these yards with woody ornamentals is important. This market need has promoted the expansion of the woody ornamental crops. On the other hand, this outdoor living does not lend itself well to the development of a market for potted plants, most of which are meant for use indoors. The situation is changing, however. The building of single-unit houses is giving way to multi-unit dwelling places and with apartment dwelling comes a greater demand for potted plants.

According to industry members, the consumption patterns in western region in many ways are models for what may happen in other parts of the United States. Essentially, a broad demand for living products to decorate outdoor playrooms and indoor living quarters, as well as weekly purchases of cut flowers, is expected to develop in other parts of the country.

H. OVERVIEW

The market for horticultural products in the United States has been expanding substantially over the past decade and is now constrained by supply. The awareness on the part of consumers for living plants in

in and around their homes or place of work has promoted this demand. Spurring growth even further has been the availability of ornamentals through a wide range of outlets, including such recent entries as the mass merchandisers.

The horticultural market is still too young to be characterized as a mature market. The changes that will take place in the coming decade are expected to put further pressure on supply and distribution and to promote greater efficiency in growing and distribution and greater price competition. These effects, in turn, will tend to limit the number of participants who can deal with the notion of systematized production on larger acreage and who can merchandise and market ornamental products in cost efficient ways.

The implications for this study are that a strong demand is present for land close to the marketplace that lends itself well to orderly production.

CHAPTER VI: FINDINGS AND RECOMMENDATIONS

A. LAWN SOD PRODUCTION

The commercial production of lawn sod on active dredged material disposal sites will not prove to be feasible. Because of the relatively frequent disruption of production during fill operations, lawn sod producers would be unable to establish the long-term capital improvements necessary for a successful enterprise. Specifically, the land grading and leveling activities considered necessary for modern production would be negated by the fill operations. Similarly, the establishment of irrigation systems would be severely hampered by the filling operations.

Frequent introduction of new soil (dredged material) to the production site may also pose serious weed control problems to the producer. Extensive weed control programs are carried out both prior to establishment and during cultivation of a sod crop. Nullification of these long-term programs on a regular basis due to use of an active site would, in itself, be sufficient reason to discourage a producer from consideration of an active site.

Finally, the production of vegetatively propagated sod varieties in the southern United States is carried out based on plans of a production cycle lasting up to fifteen years. This would appear to be impossible on an active disposal site.

Commercial lawn sod production on mature sites, on the other hand, may be feasible and may possess definite advantages for producers. The availability of low cost irrigation water supplies would prove to

be an incentive for use of a mature disposal site. Even more important to the producer would be location in close proximity to a major sod market. Since transportation costs may represent 20 percent or more of delivered sod prices, a production site which would allow lowering of these costs would improve the producers' competitive position. The potential grower must, however, be able to determine that the local market is not saturated and that he will be able to establish marketing channels.

Although lawn sod production is not limited, culturally, to any area of the United States, location near a major metropolitan area is extremely important. The strongest attraction for sod producers to establish operations on disposal sites would be the possibility of obtaining sites within 75 miles of their major market, and preferably within 10 to 30 miles.

Lawn sod producers have evidenced willingness to purchase land in desirable locations at premiums over other agricultural land. A typical producer might set \$1,200 per acre as his maximum purchase price. However, because of the regional variation in profitability of sod operations and land prices, a competitive bidding situation would be desirable. If leasing is the preferred method of granting land tenure, a long-term lease of ten years or more is necessary.

Two sets of site size criteria are available. A site or a combination of two or more neighboring sites with 30 acres or more would be sufficient for an existing local producer who wished to expand his operation. However, a producer wishing to initiate new operations or to expand to a site remote from his present operations would need 100 to 200 acres. Site access by roads capable of carrying heavy machinery and trucks is likewise essential.

Highly organic soils are considered optimum for lawn sod, although production is possible on other soils. However, production on sandy soils is somewhat undesirable because the formulation of salable turf takes longer.

Establishment of contact between potential lawn sod users of disposal sites and the authorities that handle disposition of the sites would be relatively simple. Publication of pertinent data regarding the availability of sites and their characteristics in trade journals, growers association publications, and local newspapers should prove sufficient*.

B. NURSERY PRODUCTS

High capital expenditures for site preparation and the long growing cycle for the woody nursery products make production of nursery products on active disposal sites infeasible. However, production of nursery crops on mature sites appears feasible subject to certain constraints. The most important of these are:

1. Deep, well-drained soil of proven fertility
2. Availability of irrigation water
3. Availability of large unskilled labor force.

The soil constraint may be eliminated if the nursery producer is engaged in containerized growing. In this case, soil quality is unimportant. The producer uses only the physical space.

Acreage demands for nursery producers are not severe. Sites as small as five acres would be suitable for nursery production, while 20 acres

*See listing of trade journals and grower associations, pages 90-93.

would be probably the maximum size site needed.

Proximity to market is less critical than is the case for lawn sod. Shipments of up to 400 miles are typical and in some case exceed this distance. More important to the nursery crop producer is proximity to the existing nursery industry which simplifies marketing of the products. (See Figure 2.)

While the high per acre value of nursery products allows the producer to utilize land of higher value than other horticultural crops (except foliage plants), the producer is unable to pay land values comparable to those paid by manufacturing or other industrial users.

Access roads capable of handling truck traffic are necessary for efficient production.

Marketing and distribution are not likely to constrain the nursery producer given the observed shortages in the industry and the large potential distribution area. However, the grower must ensure that marketing and distribution systems suitable for his enterprise can be established before actual production is initiated.

Trade associations such as the American Association of Nurserymen have expressed an interest in promulgating the availability of disposal sites to their membership. Several trade publications in the nursery industry also can be used for this purpose.

C. FOLIAGE PLANTS

Foliage plants are produced primarily under greenhouse conditions. This fact removes the possibility of production on active disposal sites. The necessity of a warm, frost-free climate further narrows the possible sites to the gulf coast of the United States, Florida, and

Southern California. The need for intense sunlight also precludes areas having heavy air pollution (smog) conditions from the growing of foliage plants.

However, given these constraints, use of mature disposal sites for foliage plant production appears feasible. Greenhouse growing removes any soil constraints. The only natural resource, other than climate, necessary for this production is irrigation water.

The structure of the market for horticultural plants does not preclude any climatically suitable location from production. However, given that marketing of these products is centered in Florida, the producer will probably choose to maintain a headquarter or sales office in Florida.

The value of land presently used by foliage plant producers is high. However, given the relatively minor constraints placed upon the land, other than climatic suitability, the grower would not likely be willing to pay a large premium over similar cropland in the area.

Foliage plant production will also require a large labor force and long-term land tenure.

The Society of American Florists is the principal trade association serving the foliage plant industry, though many growers also belong to the American Association of Nurserymen. Both groups have had an enthusiastic response to the possibility of having the disposal sites made available to their members and have offered their facilities and their trade publications to promulgate information.

D. VEGETABLE AND FLOWER SEEDS, BULB CROPS

Attempts to attract growers of these crops to production on disposal sites does not appear to be a worthwhile undertaking. This

production is carried out only on proven agricultural land and then primarily under contract by farmers who substitute seed as another cash crop. Disposal sites are not perceived by the seed industry as holding much potential.

E. CHRISTMAS TREE CROPS

Plantation production of Christmas trees appears feasible on mature disposal sites that possess the general site conditions required, subject to specific recommendations as to establishment of those plantations. Christmas trees are not a high-value crop such as the other horticultural crops studied. Plantations are generally established on low-value land, unsuitable for production of other crops. Thus, competition for land suitable for Christmas tree production is low as is the purchase price or rental fee. A producer probably would not pay more than \$150 per acre for land and generally would pay less.

The only major criteria other than general site characteristics needed for Christmas tree production are sandy, well-drained soil and good air drainage.

It is our opinion that, while Christmas tree production cannot compete with other horticultural crops for land use, it is a viable option for poorer soils in remote areas which might otherwise be wasted. Furthermore because of the traditional social value of Christmas trees, this production would have definite usefulness in relations with the public.

Plans to develop Christmas tree plantations can be implemented through publication of data regarding availability and site characteristics in trade journals, through a contact with the Christmas Tree Grower's Association, and through contacts with county agents and other representatives of the Extension Service and land-grant universities.

Capital investment in this enterprise is generally low and part-time; small-scale participation is possible, as well as large commercial operations. In some cases as little as 30 acres might be adequate for an enterprise.

F. DISPOSAL SITE CHARACTERISTICS

Certain general characteristics must be available at a disposal site before one considers establishment of commercial horticultural production. First, the site must be mature, i.e., no longer used for disposal of dredged material. It will not be sufficient, however, merely to cease fill operations. The site should have been removed from use for a sufficiently long period of time for drying to have been virtually completed. Whatever the drying method used, it is unlikely that a prospective grower would undertake the costly, long-term drying operations without provision of a subsidy such as reducing the land price.

The land value should be determined by the decision-making agency. The horticultural crops, while of higher value per acre than many other agricultural crops, are not able to compete in price with land for industrial or residential purposes. Although the rental rate or purchase price of the land will vary by crop, the decision to enter horticultural production must be made with the knowledge that if the land is suitable for construction, opportunity cost should be considered.

Land tenure is important to horticultural producers. To plan successful long-term investment and production operations, one must have land available for a long term, fifteen years or more, through purchase or lease.

The issue of soil fertility is likewise crucial. A first estimate of fertility can be made by assessing the vegetation which becomes established on the site. If the site is able to maintain dense vegetative growth of species typical to the area, it is a good indication that elements toxic to plant life are not present. The soil condition should then be confirmed by fertility testing, which can be accomplished at low cost by state land-grant universities or agricultural service firms. If excessive levels of salt are found to be present in the soil, horticultural production is not recommended. Finally, the disposal area and its dike structure must be secure from erosion or frequent inundation.

G. FURTHER MULTIPLE-USE STUDIES

Based upon the knowledge gained in this study, no commercial agricultural production appears to be feasible on active disposal sites. Mature sites could probably support agricultural production other than horticulture crops subject to constraints similar to those for horticultural production. However, the problem of heavy-metal uptake of food crops may pose a danger on certain sites.

A more fruitful area of exploration appears to be the use of dredged material in the reclamation of strip-mined (surface mined) land. New Federal regulations regarding reclamation, the energy crisis, environmental concerns, and a positive attitude of mine owners towards reclamation has created considerable interest in effective, minimum cost methods of restoring this land to or near its former productivity.

Current reclamation technology enables complete reclamation only at high cost, sometimes approaching \$5,000/acre. These techniques usually involve the stripping and stockpiling of topsoil and restoration following

mining. Pipeline transport of dredged material may prove to be a more cost effective method of accomplishing the task of restoring a useful soil structure and profile.

Specific studies to determine the economic feasibility of restoring agricultural land to productivity through the use of dredged material may prove beneficial, especially for midwestern coal fields and areas in Pennsylvania.

H. SEGMENTATION OF DISPOSAL SITES

Since active dredged material disposal sites were found to be infeasible locations for commercial horticultural production, segmentation of active sites to allow earlier maturing of a portion of these sites appears to be of potential benefit. This segmentation would involve construction of internal dikes within the dredged material disposal site. The site segments formed by this diking could be filled sequentially allowing early filling and maturation of the segment selected for initial use.

This technique is potentially useful on any site which possesses the characteristics necessary for successful horticultural expansion. The technique offers the advantages of early productive use of the site and the opportunity for an orderly expansion program by the producer.

ORGANIZATIONS CONTACTED

1. Agricultural Research Service
U. S. Department of Agriculture
Beltsville, Maryland
2. American Association of Nurserymen
230 Southern Building
Washington, D. C.
3. American Society for Horticultural Science
914 Main Street
St. Joseph, Missouri
4. American Sod Producers Association
9th and Minnesota Sts.
Hastings, Nebraska
5. Cornell University
College of Agriculture
Ithica, New York
6. Dewkist Nursery
Apopka, Florida
7. Economic Research Service
U. S. Dept. of Agriculture
Washington, D. C.
8. J. Hofert Company
Cadillac, Michigan
9. Horticultural Dealers Association
99 Church Street
New York, N.Y.
10. Ingleside Plantation Nurseries
Oak Grove, Va.
11. James Voster Nurseries
Coral Gables, Florida
12. Kidwell Turf Farms
Culpepper, Virginia
13. Kirk Company
Puyallup, Washington

14. John A. Koch, V.P.
National Christmas Tree Association
Birdsborn, Pa.
15. Lawn Institute
Rt. 4 Kimberdale
Marysville, Ohio
16. Leaf Nurseries
Goulds, Florida
17. Merion Bluegrass Association
18 Sommer Building
La Grande, Oregon
18. Michigan State University
Dept. of Crop & Soil Science
Lansing, Michigan
19. National Christmas Tree Growers Association
225 East Michigan Street
Milwaukee, Wisconsin
20. National Landscape Nurseyemen's Association
230 Southern Building
Washington, D. C.
21. Northrup-King
Minneapolis, Minnesota
22. Oregon State University
School of Agriculture
Corvallis, Oregon
23. Purdue University
Dept. of Agronomy
Lafayette, Indiana
24. Richlawn Turf Farms
15290 Arapahoe Road
Denver, Colorado
25. Rutgers University
College of Agriculture and Environmental Science
New Brunswick, New Jersey
26. Shammrock Turf Nurseries
Hanna, Indiana
27. Society of American Florists and Ornamental Horticulturists
901 North Washington Street
Alexandria, Virginia

28. Texas A&M University
Agricultural Experiment Station
College Station, Texas
29. Theron Stone Trees
West Olive, Michigan
30. University of California
College of Agriculture and Environmental Sciences
Davis, California
31. University of Florida
Institute of Food and Agricultural Sciences
Gainesville, Florida
32. Virginia Polytechnic Institute
College of Agriculture
Blacksburg, Virginia
33. Washington State University
College of Agriculture
Pullman, Washington
34. Wharton Turf Grass, Inc.
Wharton, Texas

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In accordance with ER 70-2-3, paragraph 6c(1)(b), dated 15 February 1973, a facsimile catalog card in Library of Congress format is reproduced below.

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